MACHINERY.

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FEEDS AND FEED MECHANISMS.*

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MACHINE tool manufacturers have been forced to redesign their machines in order to use the new high-speed tools to the best advantage. Their use has called for more power, and this increase in power has necessitated the strengthening of all the parts, and the increasing of the rigidity of the whole machine. In this increase of power, both the drive and feed mechanisms have received their share of attention, more so, perhaps, in the case of milling machines than in any of the other machine tools.

In the modern lathe and milling machine we have the all-gear feed, the changes being obtained by one of the numerous varieties of quick-acting devices. Some manufacturers still cling to the old belt and cone pulley feed mechanism, but such cases are becoming very rare, and occur mostly in the very light machines. Which is the best, it will not be within the province of this article to discuss. It would be very difficult to do so, on account of the great variation in conditions surrounding different cases. The requirements of the different types of machine tools are such that a general treatment of the problem of feed range and arrangement would not be satisfactory, as it is necessary to treat each type separately if we are to get the full benefit of such a discussion.

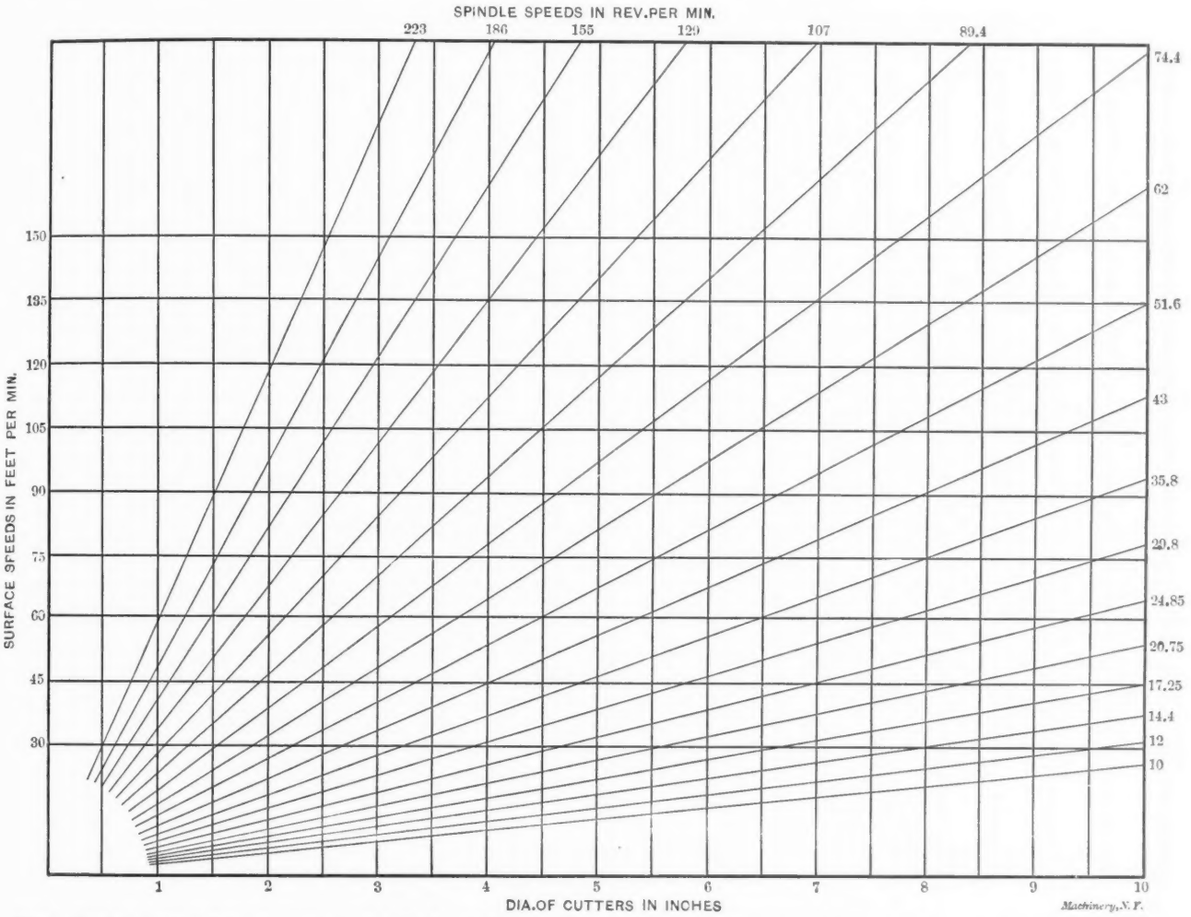

Fig. 1. Chart showing Relation between the Spindle Speed, Surface or Cutting Speed, and Diameter of Cutter for a Universal Milling Machine.

The Problem of Feed Variation for the Lathe.

We will first look into the problem as presented in the case of the lathe. In the lathe we have the work revolving on its centers with the tool fed along parallel to the axis of the work. The question is: Should the feed in turns per inch vary with the changes in diameter of the work being turned, or should it be constant and independent of the size of the work? In other words, should the feed be 1/32 inch per turn for work 1 inch in diameter and ⅛ inch for work 4 inches in diameter, or should it be held at 1/32 for all sizes of work? The designer who thinks is continually asking himself such questions as these while working out a design, and he would reason with himself somewhat on the following lines: Working under ideal conditions, it may be assumed that the tool removes a chip of equal amount from the work, irrespective of its diameter, and if such be the case, the pressure on the tool would be constant and independent of the diameter of the work. What, then, should be the arrangement of the successive steps in the feed? The material being turned is such that the work may be revolved so that it runs at, say, 20 feet per minute at the surface. This surface speed stands constant for any diameter, and requires that the work be revolved so that the speed corresponding to any diameter is obtained. The required speed for work of various diameters, running at a constant peripheral speed, was discussed in an article, "Machine Tool Drives," in the October, 1906, issue of MACHINERY.

We may now state the problem in a different manner: In having the tool remove an equal amount of metal at all times, is it necessary that the feed be constant per foot of surface passing before the tool, or should it be constant per revolution of the work? As an example, let us take three pieces of work,

* The following articles on feed mechanism and kindred subjects have previously appeared in MACHINERY: Speeds and Feeds of Machine Tools, May, 1899; Milling Machine Feed Mechanism, September, 1901; Machine Tool Drives, October, 1906.

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1, 2 and 3 inches diameter, respectively. The speeds required to give 20 feet of surface per minute are 76.4, 38.2 and 25.5 revolutions per minute, respectively. If we fix the speed at 1 inch per 20 feet of surface, or (what would be the same thing), 1 inch per minute, the feed per turn would be 0.0131, 0.0261 and 0.0392 inch, respectively. Here the feed increases with the diameter, but is constant per minute or per foot of circumference. On the other hand, if the feed is constant per revolution of the work, and that feed is, say, 1/32 or 0.03125 inch, the feed per 20 feet of surface or per minute is for the above diameters 2.385, 1.193 and 0.796 inch, respectively. These two cases are well illustrated in Fig. 2. The full line $a\,b$ is the feed line for the feed, constant per minute and varying with the diameter, and the dotted lines $a\,b_1$ and $a\,b_2$ the feed lines for feed, constant with the rotative speed, or per revolution of work. The figure shows plainly that the arrangement of the feeds, so that they vary with the diameters of the work in the same proportion, or are constant per revolution of the work, is the one that fulfills the requirements of the ideal conditions stated above.

In having the feeds vary in proportion with the diameters of the work, it follows that they, too, must follow the same laws as the rotative speeds of the work, as shown in the article in the October issue. In the lathe the feeds are arranged so that we obtain variations as turns per inch of feed, much the same as the threads per inch are obtained. In fact, the one device answers both purposes, little thought being given to the logical arrangement of feeds, they being placed in a secondary light as compared with the thread-chasing facilities, it being only necessary to extend the range of the latter to such an extent that threads fine enough to be available for feeds are obtained. This arrangement gives sufficient range, so that the working of the lathe is not handicapped by having an inadequate feed range.

Feed Mechanism for the Milling Machine.

When we come to the milling machine, we find a field worth investigating. Here the conditions are very different from what we found in the case of the lathe. We have the cutting tool revolving, and the work moving at right angles to the axis of rotation. In the lathe we had a single pointed tool, whereas in the milling machine we have a multiplicity of such tools and cutting edges. The cutting edges are formed on the periphery of cylindrical cutters, and the diameters of these cylinders vary in accordance with the conditions of the different cases encountered. These cutters are revolved so that the peripheral speed remains constant for any diameter, on the same material, and under similar circumstances. This is essentially an ideal condition, but it is necessarily assumed in order to make a basis from which we may discover the requirements as to the feeds and their range. As an example, we may say that a surface speed of 45 feet per minute is accepted as good practice on cast iron; special cases may vary either side of this mark as conditions change.

We may also assume for the sake of clearness that the number of teeth in these cutters varies in direct proportion with the diameter. In the article in the October MACHINERY (referred to above) it was shown that the speeds of cutters should vary in geometrical progression when it is desired to obtain a constant peripheral speed over a considerable range of diameters. If we also assume that each tooth composing the milling cutter should remove an equal amount of material, and do so no matter what the diameter of the cutter may be, it is evident that the feed must vary in direct proportion to the number of teeth in the cutter, which (from the preceding paragraph) gives us feeds in direct proportion to the diameter of the cutter. Thus, if we have a cutter 1 inch in diameter, feeding 0.01 inch per revolution, we would expect a 4-inch cutter to feed four times that amount or 0.04 inch per revolution. A 4-inch cutter only revolves at one quarter the revolutions per minute that a 1-inch cutter should, so that the feed per minute would be the same in each case.

From the above one might be ready to say that a very narrow range of feeds is all that conditions justify, but a little further study will prove otherwise. There are many conditions that are encountered that have a tendency to broaden the required range of feeds. Among these are: The great variation in the materials worked; the condition and design of cutters; the finish required; and the shape and size of the work. It must also be kept in mind that the assumption that the cutter will always remove an equal amount per tooth, independent of its diameter, does not hold strictly in practice, but is used here only on account of the lack of better ground on which to work.

Range of Feed required for Dependent and Independent Drives.

In the milling machine we have two systems of feed control, the "dependent" system and the "independent" system. In the dependent system the feed mechanism receives its motion from the spindle of the machine, so that when the speed of the spindle is varied, the feed is also changed in amount per unit of time, but remains the same per revolution of the cutter. With the independent system, we have the spindle and feed mechanisms driven from a common source, but the speed of either is varied irrespective of the other, so that the feed may be set a given amount per minute, and kept so throughout the full range of the spindle speeds. This latter method is the newer, and is in use with "constant speed belt" drives, in which the spindle speeds are obtained through change gears driven by a pulley running at an unvarying speed.

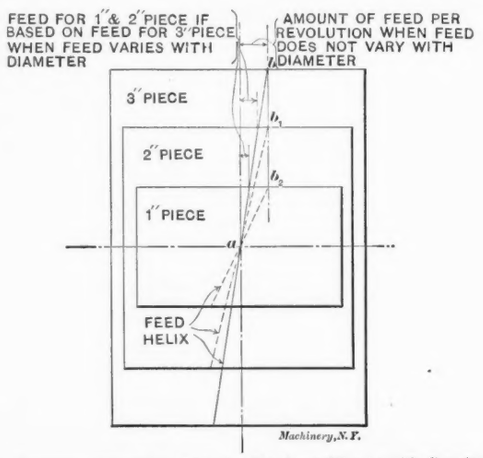
FEED FOR 1″ & 2″ PIECE IF BASED ON FEED FOR 3″ PIECE WHEN FEED VARIES WITH DIAMETER
AMOUNT OF FEED PER REVOLUTION WHEN FEED DOES NOT VARY WITH DIAMETER
3″ PIECE
2″ PIECE
1″ PIECE
FEED HELIX
Machinery, N.Y.

Fig. 2. Diagram comparing Constant Feed per Minute with Constant Feed per Revolution for the Lathe.

As an example to use in our examination of the requirements in the case of the milling machine, let us take that given in the October issue, in which eighteen spindle speeds were required, ranging from 10 to 223 revolutions per minute, in geometrical progression. We will assume that the surface speed of the cutters will range from 30 feet per minute for ordinary cutters working in hard materials, such as carbon steel, to 150 feet per minute as the maximum for high-speed cutters in soft material. Advancing by steps of 15 feet each, we may be certain of covering almost any requirement that could be met. From the spindle speeds and the full range of surface speeds we can find the diameters of the cutters suitable to use on the machine; this has been done by laying out the spindle speeds, cutter diameters and surface speeds to scale in the chart shown in Fig. 1. The largest diameter cutter used on this machine has been fixed at 10 inches. At the surface speed of 30 feet per minute and at the highest spindle speed, the chart shows that we have the proper conditions for a cutter one-half inch in diameter. Therefore we set the maximum and minimum limits of one cutter range at 10 inches and ½ inch respectively.

Following the assumption that the metal removed per tooth is the same for a cutter ½ inch in diameter as that for one 10 inches in diameter, and that the number of teeth varies directly with the diameter, we see that a feed range 10:½, or of twenty to one in inches per revolution, is necessary under one condition of material and cut. Thus, if we select 0.25 inch as the coarsest feed per revolution of cutter, the slowest feed should be $0.25 \div 20 = 0.0125$ inch. But suppose that the large cutter is to be used on soft material, and that the smaller one is to be used on very hard materials, such as

would be encountered in all tool work. We must evidently make provisions for these vastly different conditions. The feed per tooth permissible for work on the harder material, such as tool steel, is from 1/5 to 1/8 that on the softer metals, so in the present case we must extend our range until the finest feed will be, say, 1/5 of that found above, or $0.0125 \div 5 = 0.0025$ inch. This gives us a ratio of fast to slow feeds of 0.25 to 0.0025 or 100 to 1, and the feed mechanism must be designed to cover this wide range.

This is the case when we drive the feed mechanism from the machine spindle, as is done in most cone and back-gear machines, since this method of control makes it necessary to cover the whole range of feeds for each spindle speed, giving a coarser feed on the fast speeds, and a finer feed on the slow speed than is necessary. To show this, take, for instance, the high speed; the chart gives 2⅝-inch diameter as the largest cutter at this speed, and ½ inch as the smallest, giving a ratio of diameters of 5¼ to 1. If the cutters were used under the same conditions, the feed range would be ample with a fast and slow ratio 5¼ to 1; and allowing for variable conditions as we have done in the former case, by taking the slow feed at one-fifth that given, we make the range ratio 26¼ to 1, which is a little more than one-fourth that of the whole range found above.

On the other hand, if we take the highest surface speed for the largest cutter, and the fastest feed per revolution, we find by multiplying the fastest feed per minute, which is here about $60 \times 0.25 = 15$ inches. In the same way, the slowest useful feed per minute is found by multiplying the fastest speed of the spindle by the finest feed per revolution, thus: $223 \times 0.0025 = 0.5575$, or, say, ½ inch. This indicates that, so far as *necessary* requirements are concerned, the range of feed can be reduced if it is possible to drive the feed mechanism independent of the spindle, so that changes in the speed of the latter will have no effect on the speed of the former. Therefore we can, by proper designing, reduce the ratio of fast and slow feeds from 100 to 1 down to the narrower range of 30 to 1, simplifying the feed mechanism and reducing the steps between the adjacent feeds, and also reduce their number. It has been one of the objects of the so-called "single-pulley drive" machines to accomplish this.

Number and Arrangement of Feeds for Dependent Control.

Having found the range of feeds required with both systems of control, let us now turn our attention to the number and arrangement of the intermediate steps. We must find whether these steps should advance by even increments, or in geometrical progression. We will still follow the assumption that each tooth, whether in a 2-inch or a 12-inch cutter, removes an equal amount of metal, and that the number of teeth in each cutter is in direct proportion to its diameter. Referring again to the article "Machine Tool Drives," we find reasons for the grouping of the various steps in the speed range of the milling machine under discussion in geometrical progression; and since we have the teeth varying in direct proportion to the diameters of the cutters, we may apply the same reasoning to the feed range of the milling machine when the feed is dependent on the spindle for its drive, and when the feed is expressed in inches per revolution. Therefore we will arrange the feeds in geometrical progression.

The chart, Fig. 1, shows that we are correct in doing so. We have been taking it for granted that the only need for changing the feed per minute of the work, is the different conditions under which the cutter has to work; and we have assumed that for any given surface speed, the feed per minute would be the same throughout the full range of cutters possible to use at that speed. Therefore, if we select any surface speed on the chart, we will find that diameters of cutters, suitable for use at the spindle speeds provided, increase from the smallest to the largest in accordance with the law of geometrical progression, and (as we mentioned before) the teeth increase directly as the diameter, giving us feeds per revolution of the cutter that vary directly as the diameter, and thus in geometrical progression. It is apparent from the chart that the feed must increase with the same fixed ratio as the speeds, and therefore (as we found above) with the diameter of the cutters. This can be proved by taking any surface speed in the chart, finding the feeds per minute of the maximum and minimum diameter of cutters that can be used at that speed, and taking as the number of steps the number of cutters available at that speed; this is shown by the number of times the said surface speed line is cut by spindle speed lines. Then, by applying the formula for the ratio of any geometrical series, as given in the article, "Machine Tool Drives," we obtain the desired ratio. This formula is

$$\text{Log } r = \frac{\text{Log } b - \text{Log } a}{n - 1},$$

in which a is the first term in the series, b the last term, n the number of terms, and r the ratio to be found.

As an example, we will apply these methods to the 30-foot speed in Fig. 1. This surface speed allows the use of cutters varying from the smallest, ½ inch, to the largest, 10 inches diameter. It is cut seventeen times by the spindle speed lines; therefore, we have:

$$n = 17; \quad b = 0.25 \text{ inch}; \quad a = 0.0125 \text{ inch};$$

which, entered in the formula, gives:

$$\text{Log } r = \frac{\text{Log } 0.25 - \text{Log } 0.0125}{17 - 1} = \text{Log } 1.2,$$

which will be found to be the ratio of the speeds as given in the article above mentioned.

We have now found the ratio of the steps in the feed. We must next find the number of feeds necessary in order to cover all conditions reasonably possible in practice. It has been decided that the range will be set at 0.0025 to 0.25 inch, so that from these figures, with the aid of the ratio found above, we can find the number of changes.

Transposing the formula for the ratio so as to make it useful in finding the number of steps, we have:

$$n = 1 + \frac{\text{Log } b - \text{Log } a}{\text{Log } r}.$$

Solving for the problem in hand, we have:

$$n = 1 + \frac{\text{Log } 0.25 - \text{Log } 0.0025}{\text{Log } 1.2} = 26.2.$$

As it is possible to use only whole numbers, we will choose 26 as the number of changes in the feed for our machine when arranged for dependent feed control.

Laying Out an Independent Feed System.

Since so great a number of feeds would require us to employ a rather complicated mechanism when the feeds are controlled by the spindle, let us see what range and progression of feeds would answer in the case of the independent control. We have already found that the feed needs only to cover a range of from ½ inch per minute to 15 inches per minute, between which limits we have a feed suitable for any practical condition. Designers in general have chosen geometrical progression as the proper method of arranging the feeds in the case of independent control as well, and the virtue of the choice will be conceded by any one who has any dealings with the milling machine.

[We omit here the reasoning given by Mr. Edgar for preferring the geometrical progression in the case of independent feed control. It may be said that, from the nature of things, this method of spacing feeds and speeds is universally a correct one in any machine intended for general use under widely varying conditions. With arithmetical progression we have so many revolutions per minute, or so many inches per minute difference between each step of the speed or feed. This, however, gives us no clear idea as to the closeness with which the steps are spaced. If, for instance, with arithmetical progression, the difference between successive feeds is 2 inches per minute, and the first feed in the series is 1 inch per minute, the second feed will be 3 inches per minute; the tenth will be 19 inches per minute, and the eleventh will be 21 inches per minute. Now, while the difference between the first and second step is exactly the same as that between the tenth and eleventh, it does not require any great perspicacity to see that the jump between the two feeds in the first case is much more violent than in the latter example. Feed two is,

in fact, three times as great as feed one, and in saying this we at once admit that the proper way to compare feeds is to find the factor (3 in this case) which, multiplied by the lower one, will give the next higher one; and if we wish to have the feeds evenly and properly distributed this factor should evidently be constant. In other words, the steps should be arranged in geometrical progression.—EDITOR.]

We may take 16 as the number of changes, which number is an arbitrary value in this case, determined by the desirability of keeping down the ratio between successive feeds on the one hand, and the inadvisability of complicating the feed mechanism on the other. Applying the formula previously given for determining the ratio for 16 feeds, with the smallest feed ½ inch per minute and the largest one 15 inches per minute, we have:

$$\text{Log } r = \frac{\text{Log } 15 - \text{Log } 0.5}{n - 1}.$$

$$r = 1.255.$$

As mentioned, the dependent control system is the result of the "cone and back gear" method of obtaining the various speeds, and is the best that the designer can make of a bad bargain—except that which is far worse, *viz.*, driving the feed independently from the countershaft without a positive connection between the spindle and feed mechanism. With this arrangement, whenever the spindle stops for any one of the many possible causes, the feed will keep on feeding, to the ill health of the cutter surely, if not of the machine itself. We must have a positive connection between the feed and spindle when we control the feed mechanism independently of the spindle speeds.

* * *

The following mixture, the composition of which has been published in the *Brass World*, has been found excellent for bronze name plates: Copper, 90 per cent; tin, 6 per cent; zinc, 2.5 per cent; lead, 1.5 per cent. If the lead is left out the bronze will usually dip better, but when any machine work is to be done upon the name plates, lead is added.

A MACHINE SHOP EMERGENCY ROOM—THE SHOP IN WHICH IT WAS FOUND.

In paying a random visit, recently, to the shops of a New England firm, engaged in the building of light machinery, the writer discovered a feature of their equipment which seemed worthy of description. The feature referred to is the "emergency room," shown in Fig. 2. This room, which is in reality a miniature hospital, was fitted up in an unused space in one of the stairway towers. It is surprising in its completeness. The room is rather small, so that it was difficult to get a good picture of it, and all of the equipment does not show in the cut. There will be seen, however, the stretcher, a stand for the doctor's instruments and bottles, wash basins and stand, a cupboard for drugs, bandages, etc., and an enameled, glass front cabinet for the surgeon's tools. At the other end of the room there is a lavatory of white enamel.

The set of instruments and accessories provided is quite elaborate. They include a tourniquet, scalpels, scissors, forceps, needles, etc., with an instrument sterilizer for putting them in an aseptic condition. There is also a supply of nail brushes, dressing basins, water bottles and irrigator stands. Rows of bandages, absorbent cotton, sterilized gauze, plasters, etc., may be seen in the cut on the shelves of the cupboard. The labels of the bottles are mostly meaningless to the layman, although he can get some dim comprehension of the meaning of such terms as "1 Qt. W. Green Soap," "1 Pt. Castor Oil and Bals. Pem." Ether and cocaine, with the necessary inhalers and hypodermic syringes, are also at hand.

The purpose of this room and its equipment is that of having ready at hand all the necessary appliances for taking care of any injury, whether slight or serious. Sticking plasters and bandages may of course be applied at once by any one, but in cases of dangerous injuries a physician is at once sent for, who can come to the shop without delay, and with the knowledge that he will find everything ready at hand for his convenience, without necessitating the loss of the time

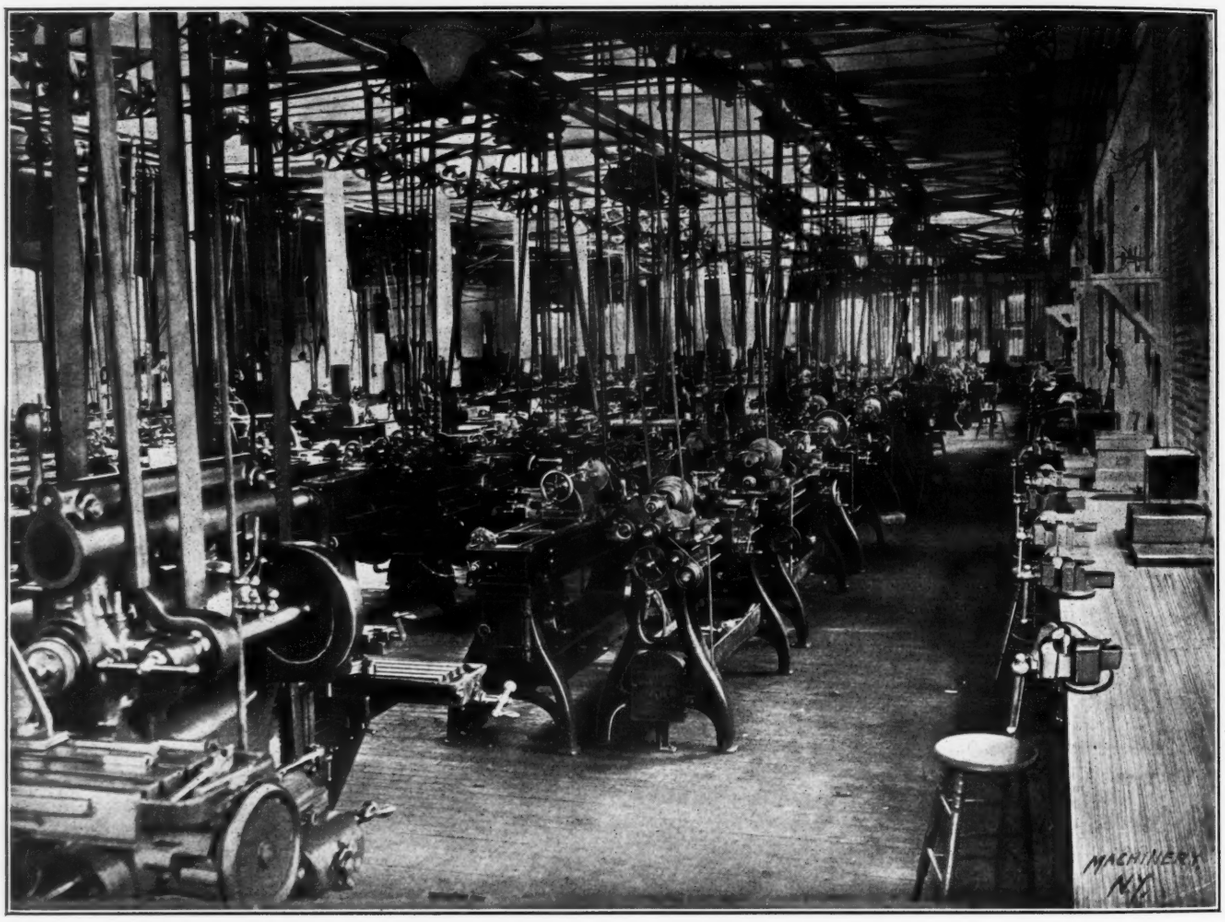

Fig. 1. View of a Portion of the Tool Room of a Firm engaged in Contract Work.

required in taking a badly injured patient to the hospital, or the inconvenience and danger of treating the patient in the shop with such conveniences as the physician could hastily get together.

In conjunction with, and supplementing the mission of this department, there has been established a series of lectures on "first aid to the injured" or "junior surgery." There will be ten of these lectures running through as many weeks, open to the employes of the company. The course has been recently entered upon with an attendance of between 50 and 75, and is in charge of a prominent physician and surgeon of the city.

Aside from this emergency room, and aside also from the many interesting machines and operations which are to be seen in this plant, which is that of the Taft-Peirce Co., Woonsocket, R. I., the business of the concern is an interesting one. The work of the shop is contract work entirely, nothing whatever being built and marketed by the firm. The general run of the machinery manufactured is of the small to medium automatic variety, of all degrees of complication. In the list of products may be mentioned knitting machinery, type-setting machinery, typewriters, sewing machines, cream separators, button-making machinery, and a host of special machines for performing almost every operation conceivable, that can be performed by machinery or human hands.

The business of the shop may be divided roughly into two parts—that of development, and that of manufacture. To accommodate the various firms and individuals who are having development work done, one end of the upper floor of the

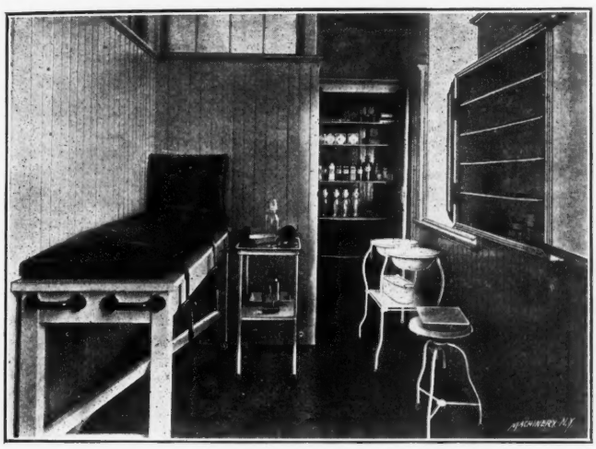

Fig. 2. A Miniature Hospital for a Machine Shop.

main building is partitioned off into a great number of small rooms, where designers, furnished by the Taft-Peirce Co., or hired by its customers, work at the drawing board, developing machinery, within easy reach of the machinists and model makers who are constructing it. On this same floor is the "tool-room," where jigs, fixtures, etc., are made, and the experimental work is done, together with any other operations requiring highly skilled labor. A portion of the room is shown in Fig. 1.

The manufacturing end of the business engages in the building of machinery after the design has been developed to a satisfactory degree, and the required jigs, fixtures and special tools have been made for it. This department comprises the greater part of the plant, and some idea of its extent may be obtained from Fig. 3, which shows the equipment of surface grinders used. These are all furnished, as shown, with magnetic chucks. Probably few readers of MACHINERY have ever seen so many surface grinders together at one time. The crude stock room shown, in part, in Fig. 4, is also impressive in its size for a plant of this kind.

It will be seen that the field of the firm is the furnishing of drafting-room, tool-room and manufacturing plant to inventors and patent owners of machinery, who do not think it wise to go into business for themselves. These facilities are provided ready at hand in a highly developed form, and it is safe to say that it would be difficult on the spur of the moment for a prospective manufacturer to collect an organization equal in efficiency to that which he will find here ready at hand.

A CHALLENGE TO SIR RUDIS SEMPITERNE.

I have read with much admiration the epoch-making essays that Sir Rudis Sempiterne has deigned to contribute to MACHINERY. Great classics these, which have carried sweet edification to millions of readers, beheaded at one stroke the mathematical monster, and will be remembered, with feelings of mingled reverence, tenderness and gratitude, when Euclid and Archimedes, Huygens and Newton, Euler and Lagrange have sunk in the night of oblivion. With that Christian humil-

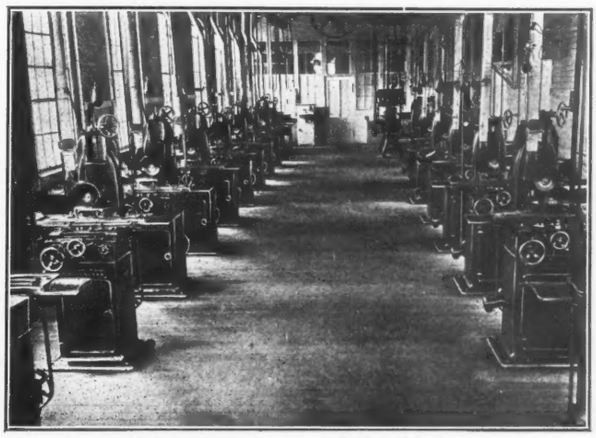

Fig. 3. Unusual Array of Surface Grinders.

ity and that disinterestedness which often characterize the great benefactors of human kind, Sir Rudis has endeavored to conceal his identity by attaching only the apparently insignificant combination "R. S." to his masterpieces; nor would he have condescended to use even these letters, had he not been prompted by the generous impulse of having Sir Res Simplicissima, who is somewhat known by his initials, receive the credit for what he, Rudis, has evolved out of his subcranial depths. There has been much discussion regarding the merits of these two luminaries, some holding that Simplicissima is the profoundest thinker that the world has produced, others that Rudis' learning is equally superlative, while others have suspected that the two names represent but one man. However this may be, it is my opinion that they are both too far above our common intellectual atmosphere to be judged by ordinary mortals, and that, at any rate, Rudis' profundity is no less deep than that of Simplicissima, nor is the learning of Simplicissima less learned than that of Rudis.

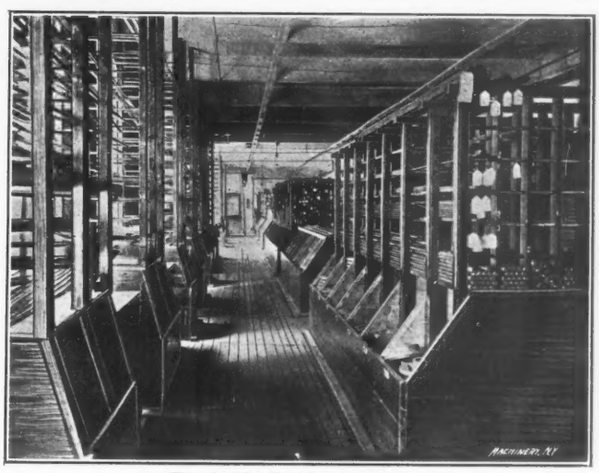

Fig. 4. The Crude Stock Room.

Sir Rudis is at once an iconoclast and a creator, a soldier and a prophet; and one does not know which to admire most, whether his courage, his beatific serenity, his superhuman vision, or the apparent simplicity of his astounding discoveries. In a few lines and with a few lines, he has exposed Euclid's fallacies, and, dragging the old pretender from his usurped pedestal, has proved him to be an *Equus asinus* (what the vulgar call an ass). And this he has done by demonstrating that things are not what they are, but what they look;

that lines do not meet where they do, but where they don't, and are not as long as they have length, but only as long as is necessary or convenient; and that an isosceles triangle may have three unequal sides, it being perfectly obvious that one of the equal sides may be longer or shorter than the other, according to the psychological requirements and acquirements of the investigator. Here we already have an adumbration of that grand synthesis toward which the powerful mind of Sir Rudis has been gravitating—namely, the universal law that all things are equal. In his April production, he has established this law more directly; and to that production we must now turn our attention.

Some *homo ignotus* (unknown or obscure man, gentle reader) having proposed the problem of finding the radius of a circular arc, knowing the lengths of the arc and chord, Sir

Sir Me Too's Idea of Sir Rudis Sempiterne on a Voyage of Discovery.

Rudis, in his eagerness to be of service, lays aside his pet perpetual-motion machine, loads his powerful guns, clears for action (and perhaps for reaction), and attacks the problem in this fashion:

Let R, C and x be, respectively, the radius, chord and rise of the arc. Neither R nor x is known, but they can both be determined by means of the two following equations, derived from elementary geometry:

$$R^2 = \left(\frac{C}{2}\right)^2 + (R - x)^2 \qquad (1)$$

$$(2R - x)\,x = \left(\frac{C}{2}\right)^2 \qquad (2)$$

Having delivered himself of these two precious twins, he returns to his machine, leaving to his readers the vulgar operation of solving the equations, and to the learned the task of unfolding the profound doctrine that they symbolize. Some uncritical critics and unmathematical mathematicians have presumed to denounce these equations, repeating like parrots a jargon in which the cabalistic terms "simultaneous" and "independent" take the place of true reasoning. But the bellowing of such cattle is not worthy of notice. Let us set aside all traditional dogmas, and look at those two equations in the light of science.

Subtracting equation (2) from equation (1), we have

$$R^2 - (2R - x)x = (R - x)^2,$$

that is,

$$R^2 - 2Rx + x^2 = (R - x)^2,$$

or, since the first member is the square of $(R - x)$,

$$(R - x)^2 = (R - x)^2;$$

whence, extracting the square root,

$$R - x = R - x$$

Adding x to both members of this equation, we get

$$R = R \qquad (3)$$

It also follows, according to the principles of higher algebra, that

$$x = x \qquad (4)$$

Equations (3) and (4) solve the problem. Having found R and x by these two equations, the value of C can be found from equation (2). It is true that C was given, but one of the merits of the new method consists in that it enables us to find the known from the unknown. Thus, after finding R, x, and C, these values may be substituted in equation (1) to find the value of 2; that is, to determine whether 2 is equal to 2 or to something else (remember the isosceles triangle with unequal sides). This, however, is of no practical importance; for, as will be shown presently, all numbers are equal.

The consequences following from the above investigation are so great that I shall state them as universal laws:

LAW I.—*Everything is equal to itself.* This law, now stated for the first time, follows from equations (3) and (4).

LAW II.—*Everything is equal to everything else, itself included.* As will be observed, Law I. is but a special case of Law II.; so that, in reality, Law II. is the one universal, fundamental law. Although this law does not follow directly from any of the foregoing equations, it is an irrefutable consequence of Sir Rudis' new method of solving equations. It will be observed that the values of R and x were found independently of the given length of the arc, as well as of the length of the chord; that is, the solution of the problem is independent of the data. It follows that, whatever the length of an arc and the length of its chord may be, the radius and the rise remain the same. A little reflection will make it manifest that this is equivalent to saying that all circles have the same radius and all chords the same rise; and, as every number can be assumed to represent the radius of a circle, all numbers are equal; and, as everything, when measured, can be represented by a number, all things are equal, or everything is equal to everything else. Which was to be proved.

There being but one number, plurality is impossible; and, therefore, there exists but one thing in the universe. Here we have at last a mathematical demonstration of what philosophers call monism, and equations (3) and (4) may be called the monistic equations of the cosmos.

Having expounded Sir Rudis' new logic, and given him due credit for his startling discoveries, I purpose to carry the investigation a step further, and, by proving that nothing exists, reduce his monism to nihilism, or nothingism. His universal law establishes the fact that all numbers are equal, or, what is the same thing, that there is but one number, which is a constant. This one and only number I was at first tempted to call the Rudisian, following the example of old-fashioned mathematicians, who speak of Hessians and Jacobians, Laplacians and Gudermannians; but, considering that it is I, not Sir Rudis, who has determined its value, I must, in justice to myself, call it the Metooian. This constant, which is the synthesis of everything that exists, is zero; so that nothing, not even Sir Rudis himself, is real; or, expressed in other terms, the only thing that exists is nothing, everything else being non-existent. As Sir Rudis may not assent to this proposition, I hereby challenge him to refute my reasoning; and, unless he proves that my logic does not comply with the canons laid down by Aristotle and Hegel, he must confess himself vanquished in fair combat, and, sheathing his mighty sword, must abstain from again entering MACHINERY'S lists.

It is a well-known principle of mathematics that, whatever the number a may be, the following equations are true:

$$(\sqrt{a})^2 = a$$

$$(\sqrt{a})^2 = \sqrt{a} \times \sqrt{a} = \sqrt{a \times a} = \sqrt{a^2} = a$$

Let now $-x$ be substituted for a. Then,

$$(\sqrt{-x})^2 = -x$$

$$(\sqrt{-x})^2 = \sqrt{-x} \times \sqrt{-x} = \sqrt{(-x) \times (-x)} = \sqrt{x^2} = x$$

Therefore,

$$x = -x;$$

whence, transposing and solving for x,

$$2x = 0,\ x = 0.$$

Now, x is any number whatever; therefore, every number is

equal to zero; and, as everything can be represented by a number, everything is equal to nothing; or, in other words, nothing exists. This is so transcendent a law, that I shall give two other demonstrations of it.

It is proved in elementary mathematics that

$$\sqrt{\frac{m}{n}} = \frac{\sqrt{m}}{\sqrt{n}}$$

and that, whatever the value of x may be, $\frac{x}{-x} = \frac{-x}{x}$. Therefore,

$$\sqrt{\frac{x}{-x}} = \sqrt{\frac{-x}{x}}$$

that is,

$$\frac{\sqrt{x}}{\sqrt{-x}} = \frac{\sqrt{-x}}{\sqrt{x}}$$

whence, clearing of fractions,

$$(\sqrt{x})^2 = (\sqrt{-x})^2; \text{ or } x = -x,$$

and, as before,

$$2x = 0,\ x = 0;$$

which again shows that every number is equal to zero.

The following demonstration is, in my opinion, the most elegant and cogent; and, as it is based on things infinite, it possesses a grandeur and majesty that accord and harmonize with the grand and majestic proposition that it proves.

By the application of what they call the theory of limits, mathematicians have proved that, when x is equal to infinity, we have, whatever a may be,

$$a\left[1 - \left(1 - \frac{1}{x}\right)^x\right] = \frac{a}{e}(e - 1) \qquad (5)$$

In this formula, e is an unearthly and ungodly fixed number invented about 300 years ago by Logarithmic Napier, a very troublesome Scotchman; its value is not anything in particular, but is a little greater than 2.7. This number is irrational and transcendental, and is classed among the incommensurables of the number continuum. The reader, of course, is thoroughly familiar with these facts and terms, and I shall not offend his learning by giving superfluous explanations.

Now, it is also admitted that, when x is infinite, $\frac{1}{x} = 0$, and that all powers of 1 are 1. Thus, when x equals infinity,

$$a\left[1 - \left(1 - \frac{1}{x}\right)^x\right] = a\,(1 - 1) = a \times 0 = 0$$

Comparing this equation with (5), we have

$$\frac{a}{e}(e - 1) = 0;\ a = \frac{0 \times e}{e - 1} = 0$$

and, as a is any number, we again arrive at the conclusion that all numbers are equal to zero.

In order that my theory may leave nothing to be desired, I shall prove that even those elusive mathematical ghosts called imaginary quantities come within the all-embracing extension and comprehension of the G. M. (the Grand Metooian).

Let e denote, as usual, the aforementioned logarithmic pet of the aforementioned voodoo Napier; i, the universal fake, or $\sqrt{-1}$; and π the well-known-yet-not-found dementia germ. As the reader, of course, knows, these three quantities are related by the following equation:

$$e^{2\pi i} = 1$$

This equation may be written:

$$(e^{\pi i})^2 = 1;$$

whence, extracting the square root,

$$e^{\pi i} = 1.$$

We have also, since the zero power of any quantity is equal to 1, $e^0 = 1$. Therefore,

$$e^{\pi i} = e^0;$$

whence

$$\pi i = 0;\ \text{and } i = \frac{0}{\pi} = 0;\ \text{or, } \sqrt{-1} = 0.$$

It is thus shown that the imaginary fake, too, is a nonentity. Now I shall rest, repeating my defiance of Sir Rudis, whom I again challenge in the name of St. George and Sir Archimedes, of Sir Galileo, and Don Quixote, and Teddy.

SIR ME TOO.

SHOP WORK IN AN ENGINEERING SCHOOL.

W. S. GRAFFAM.*

The question is often asked: "What is the final aim of shop practice in an engineering school?" We say shop practice, for that is what it really is, whether it be called engineering laboratory work, mechanical arts, manual training or whatever term may be used. It is still practice or work in the shops.

The Aim of Shop Practice.

Is the aim of such shop practice simply the training of the hand, the mind, the eye? Is it just the development of the skill or control over the muscles governed by the mind, or is it the training of the judgment of the pupil in regard to the best, quickest, easiest and most accurate methods of achieving certain results? To be sure, all these are valuable results of shop work when properly taught; but in an engineering school, cannot the pupil be taught some of the deep engineering principles at the same time, facts that will be of much practical benefit to him after graduation?

While perhaps some of the fundamental principles of certain branches cannot be well taught without a fixed set of exercises, still is it not better to assign practical projects to be carried through? A very simple piece of comparatively useless wood may be the outcome of a chiseling exercise, but would it not be of more value if that exercise should teach some practical joint used in building construction or cabinet work? A flat piece of cast iron into which a hole is to be drilled might teach the pupils the use of the drill and drill-press; but if that hole is required to be drilled in a certain place and manner in order that the finished piece will fit into a given machine in a certain way, according to its shape and size, it will the more forcibly impress upon the student the reason why it was thus made. These practical projects, the construction of useful pieces in woodwork, of actual machines and apparatus that are to be put to the test when finished, will go far toward teaching the pupil direct engineering facts as well as to stimulate his interest in the work.

Where is an Engineering Student to Learn Shop Practice if Not in the School?

Take, for example, a young man coming from the ordinary home or perhaps from the farm. He has either worked around the home or attended school all his life. He is studying to be a mechanical or electrical engineer and may, along with a large number of others, enter the field of manufacturing. Where is he to receive that training in shop discipline, in shop management, in the selection and care of shop equipment and tools, in the system which warrants rapid and cheap production, in the selection of materials and men, if he does not get it while he is a student at his chosen school?

Need of First-class Machinery in Schools.

This suggests the subject of machines and apparatus. The graduate may enter the employ of a thriving firm. Has he had the privilege during his engineering course of working upon the best and most improved machinery, so that he will know the capacity and usefulness of such? Are the machines he has been used to so varied in their make that he knows at once which ones are best adapted to the work in hand? Has he been obliged to do milling machine work on a planer, or turret machine work on an ordinary lathe because of the lack of these two machines? If such is the case, why criticise the man because he does not get into line sooner after graduation?

To be sure, the necessity of working in a roundabout way to accomplish something that should be done by a short-cut method develops the inventive faculties of the student; but because he is obliged to perform his shop-work in this manner does not prove that he should also get his practical knowledge of the proper methods of manufacturing in a similar indirect way.

Of course it will be said that not all of our schools can afford to keep up with the latest and most improved methods and machines, and undoubtedly such is the case. The depreciation on such equipment is just as great as it is on the same machines in a manufacturing establishment, but in the latter

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case the machines are paying for themselves, while such is not the case with the former. Many schools cannot afford to scrap their machines when they are but half worn out for the sake of securing those of a more improved design. Hence to a great extent the student must be content with getting the fundamental principles of the work on machines and apparatus that have long since seen their best days. The writer has in mind a reputable engineering school where until but a few years ago the only milling machine in the shops was a very small Brown & Sharpe machine built in 1868!

Need of Shop Discipline.

Now let us consider, in a brief space, the effect of the conditions of our shops upon the student. Should not our motto be, "A place for everything and everything in its place"? I would add one phrase more to that and say: "and ready for use." If our shops are allowed to be untidy, the machines dirty, the small tools dull and broken, with no proper place for anything, then we must expect our graduates to carry the impressions of such shiftless ways out into the world with them. If they are required to keep their machines clean and the tools in condition to use, then they are very likely to require those whom they may in the near future employ to do likewise. It is to be realized that there are many of the smaller schools where the care of the shops and the shop instruction all falls upon one man, who, unless he can have complete cooperation on the part of students, faculty and instructors, cannot possibly keep things in the proper condition.

There are many difficulties in the path of the one who, aside from doing all the teaching in the shop courses, is required to care for all the tools and equipment of the shops. He cannot be in more than one place at a time, and if he has a class in one shop it is very inconvenient for him to leave in order to hand out tools and stock to someone who desires to work in some other place at the same hour. To throw the shop or tool-room open to the average student to do some little job for himself or for the department in which he has been working, is usually disastrous. Many times tools will not be in proper condition when returned, and very seldom will they be returned to their proper places. This causes untold inconvenience and delay, if not annoyance, when a class comes into the shop for instruction. Often it is the instructor in some other department of the institution who requests the shop privilege for a time. He may never have had any experience in the use of the equipment he desires to use. His intentions may be of the best, but his lack of experience and knowledge often results in serious damage to valuable machines and apparatus, as well as much delay in class work. It cannot be expected that one who does not know all of the little ins and outs of the various lines of shop-work can work for several hours in the machine shop and tool-room without leaving his marks behind him. It is as serious a matter for a person who is accustomed to teaching languages or chemistry only to attempt or assume the privilege of the use of the machines and tools of the machine shop, as it would be for the shop instructor to assume the same privilege in the use of the delicate apparatus and instruments of the departments of chemistry or physics.

So it would seem that to be sure of having the shops in the best condition for most economical and efficient instruction of classes, private work would have to be prohibited entirely, or limited to the hours when the shop instructor is at liberty to be present. "Eternal vigilance" must be the watchword of him who desires to achieve the best results with shop instruction.

Commercial Conditions Most Conducive to Inculcating Shop Knowledge.

These difficulties are most easily overcome where the institution carries on some line of manufacturing in its shops, for then there must be journeymen mechanics and tool-room attendants who can look after things properly. Nothing can be better for the student than to get his shop practice where there is practical commercial work going on. He has an opportunity of comparison between his own work and that of the experienced mechanics about him. He observes the short-cut methods of rapid production, and can compare the time it takes him to do a certain piece of work with the time the tradesman takes. Commercial work gives the shop a tone of thrift and movement which cannot be found or had in the average school shop. Such thrift is generally contagious, and if correct system is in use, the impressions the student will receive will be lasting. He can also see at once the commercial value of his labor, and it stimulates him to higher attainments than usual with the average workman.

With the small amount of time that is usually allotted to the pupil's practice in the shops, his projects will necessarily be comparatively small pieces. But if commercial work is being turned out, he can note the methods employed in the marketing of the product from the design to completion and even installation of many large pieces of work. The value of such opportunity cannot be overestimated.

Number of Hours given to Shop-work too Small.

It may not be out of place at this point to give a little consideration to the amount of time usually allotted to these lines of work. While there is much diversity among our various institutions in regard to the number of hours given to shop-work, it must be admitted that the average is far too small. Think for a moment of a school that allows two semester hours for wood-work and scarcely more for pattern-making and wood turning. The school term may be eighteen weeks in length, giving 108 actual hours work in periods of three hours each; fourteen and a half days of practice at eight hours per day. Then think of the numerous details and principles underlying the subject of pattern-making, and see how the two compare proportionally. Compare also in like manner the intricacies of machine construction with twice that amount of time allotted to it, and see where you are. Teach pattern-making in 14½ days, and machine-work in 29 days! No, it cannot be done. It is not expected that it is to be done, but we can teach at them, and the wonder is that it is possible to accomplish so much in so short a time.

It may seem as though the writer is trying to decry the advisability of shop-work in the engineering school, but such is not the intention. On the other hand, he has the greatest faith in what can be accomplished along this line, and when it is a fact that some of our schools are giving only half this amount of time to some lines of shop practice, he desires to enter a plea for more weight to be given to the value of the work, and more time to be allotted to it.

Can a Shop School be Made to Pay?

Not long ago, at the founding of a new school, the question was asked if it were possible for student shop-work to be made self-sustaining. Could it be made to pay enough financially to meet the expenses? While this might be made possible under certain favorable conditions, it is not liable to be the case. If a student's work is made to pay, there must be a sacrifice of much of his valuable time and education. A person's "first job" is scarcely ever as good as his second, nor his second as good as his third. The student's work is always his "first attempt," and the quality cannot be expected to compare favorably with that of the master mechanic's; and second-class work never pays when put on the market. If he is kept on one line of work long enough to perfect himself in that line, then so much of his time allowed for shop-work in general has been sacrificed as to preclude his gaining the principles of some other branch that is likely to be of much value to him educationally.

Conclusions.

Thus it would seem that for an institution to be the most efficient in teaching the student the principles underlying the various branches in shop-work, there must be good system in shops and tool-rooms; a large variety in size and make of machines and apparatus; excellent order and care of equipment; commercial work, carried on by journeymen mechanics; and much thoughtfulness and consideration on the part of all those connected with the institution who are interested in the development of the practical side of the student's education. These conditions combined with the best of instruction will go far toward fitting the graduate student for solving the problems he will encounter soon after he enters the manufacturing field.

CALCULATING THE DIMENSIONS OF WORM GEARING.*

RALPH E. FLANDERS.†

This article makes no pretense of giving any new information, nor of treating the subject from a new standpoint. It is intended to be simply a compilation of rules for the calculation of the dimensions of worm gearing, expressed with as much simplicity and clearness as the writer can attain to.

No attempt has been made to give rules for estimating the strength or durability of worm gearing, although the question of durability, especially, is the determining factor in the design of worm gearing. If the worm and wheel are so proportioned as to have a reasonably long life under normal working conditions, it may be taken for granted that the teeth are strong enough for the load they have to bear. No simple rules have ever been proposed, so far as the writer is aware, for proportioning worm gearing to suit the service it is designed for. Judgment and experience are about the only factors the designer has for guidance. In Europe, a number of builders are regularly manufacturing worm drives, guaranteed for a given horse-power at a given speed. The dimensions of these drives are not made public, however; they would doubtless be of great value for purposes of comparison if they could be obtained. In the absence of these or other practical data, the writer has dodged the issue entirely.

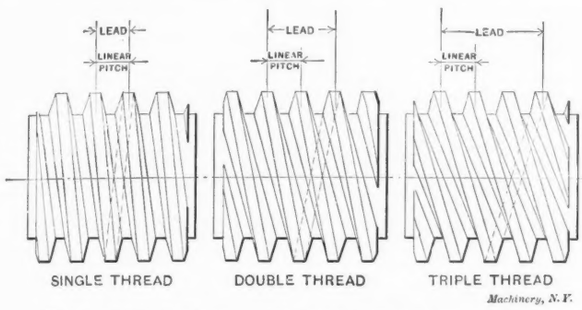

Fig. 1. Distinction between the Terms Lead and Linear Pitch as Applied to Worms.

Definitions and Rules for Dimensions of the Worm.

In giving names to the dimensions of the worm there is one point in which there is sometimes confusion. This relates to the distinction between the terms "pitch" and "lead." In this article we will follow the nomenclature indicated in Fig. 1. Here are shown three worms, the first single-threaded, the second double-threaded, and the last triple-threaded. As shown, the word "lead" is assumed to mean the distance which a given thread advances in one revolution of the worm, while by "pitch," or more strictly "linear pitch," we mean the distance between the centers of two adjacent threads. As may be clearly seen, the lead and linear pitch are equal for a single-threaded worm. For a double-threaded worm the lead is twice the linear pitch, and for a triple-threaded worm it is three times the linear pitch. From this we have:

RULE 1. *To find the lead of a worm, multiply the linear pitch by the number of threads.*

It is understood, of course, that by the number of threads is meant, not the number of threads per inch, but the number of threads in the whole worm—one, if it is single-threaded, four, if it is quadruple-threaded, etc. Rule 1 may be transposed to read as follows:

RULE 2. *To find the linear pitch of a worm, divide the lead by the number of threads.*

The standard form of worm thread, measured on an axial section as shown in Fig. 2, has the same dimensions as the standard form of involute rack tooth of the same linear or circular pitch. It is not of exactly the same shape, however, not being rounded at the top nor provided with fillets. The thread is cut with a straight-sided tool, having a square, flat end. The sides have an inclination with each other of 29 degrees, or 14½ degrees with the center line. The following rules give the dimensions of the teeth on an axial section for various linear pitches. For nomenclature, see Fig. 2.

RULE 3. *To find the whole depth of the worm tooth, multiply the linear pitch by* 0.6866.

RULE 4. *To find the width of the thread tool at the end, multiply the linear pitch by* 0.31.

RULE 5. *To find the addendum or height of worm tooth above the pitch line, multiply the linear pitch by* 0.3183.

RULE 6. *To find the outside diameter of the worm, add together the pitch diameter and twice the addendum.*

RULE 7. *To find the pitch diameter of the worm, subtract twice the addendum from the outside diameter.*

RULE 8. *To find the bottom diameter of the worm, subtract twice the whole depth of tooth from the outside diameter.*

RULE 9. *To find the helix angle of the worm and the gashing angle of the worm-wheel tooth, multiply the pitch diameter of the worm by* 3.1416, *and divide the product by the lead; the result is the cotangent of the tooth angle of the worm.*

Rules for Dimensioning the Worm-wheel.

The dimensions of the worm-wheel, named in the diagram shown in Fig. 3, are derived from the number of teeth determined upon for it, and the dimensions of the worm with which it is to mesh. The following rules may be used:

RULE 10. *To find the pitch diameter of the worm-wheel, multiply the number of teeth in the wheel by the linear pitch of the worm, and divide the product by* 3.1416.

RULE 11. *To find the throat diameter of the worm-wheel, add twice the addendum of the worm tooth to the pitch diameter of the worm-wheel.*

RULE 12. *To find the radius of curvature of the worm-wheel throat, subtract twice the addendum of the worm tooth from half the outside diameter of the worm.*

The face angle of the wheel is arbitrarily selected; 60 degrees is a good angle, but it may be made as high as 80 or even 90 degrees, though there is little advantage in carrying the gear around so great a portion of the circumference of the worm, especially in steep pitches.

RULE 13. *To find the diameter of the worm-wheel to sharp corners, multiply the throat radius by the cosine of half the face angle, subtract this quantity from the throat radius, multiply the remainder by* 2, *and add the product to the throat diameter of the worm-wheel.*

If the sharp corners are flattened a trifle at the tops, as shown in Figs. 3 and 5, this dimension need not be figured, "trimmed diameter" being easily scaled from an accurate drawing of the gear.

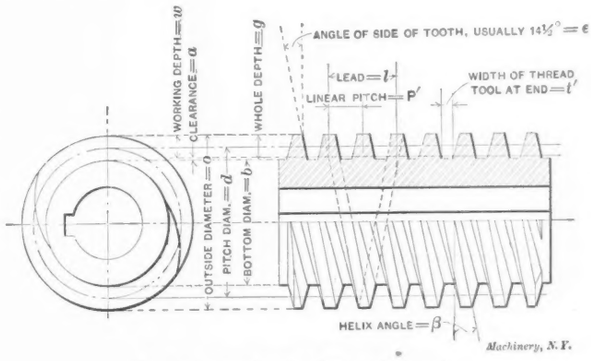
WORKING DEPTH = w
CLEARANCE = a
WHOLE DEPTH = g
ANGLE OF SIDE OF TOOTH, USUALLY 14½° = ε
LEAD = l
LINEAR PITCH = p
WIDTH OF THREAD TOOL AT END = l'
OUTSIDE DIAMETER = o
PITCH DIAM. = d
BOTTOM DIAM. = b
HELIX ANGLE = β
Machinery, N.Y.

Fig. 2. Nomenclature of Worm Dimensions.

There is a simple rule which, rightly understood, may be used for obtaining the velocity ratio of a pair of gears of any form, whether spur, spiral, bevel, or worm. The number of teeth of the driven gear, divided by the number of teeth of the driver, will give the velocity ratio. For worm gearing this rule takes the following form.

RULE 14. *To find the velocity ratio of a worm and worm-wheel, divide the number of teeth in the wheel by the number of threads in the worm.*

Be sure that the proper meaning is attached to the phrase "number of threads" as explained above under Rule 1. The revolutions per minute of the worm, divided by the velocity ratio, gives the revolutions per minute of the worm-wheel.

RULE 15. *To find the distance between the center of the worm-wheel and the center of the worm, add together the pitch diameter of the worm and the pitch diameter of the worm-wheel, and divide the sum by* 2.

RULE 16. *To find the pitch diameter of the worm, subtract the pitch diameter of the worm-wheel from twice the center distance.*

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* The following articles on worm gearing have previously appeared in MACHINERY: Worm Gearing, December, 1902, engineering edition; Theoretical Efficiency of Worm Gearing, December, 1903, engineering edition; An Example of Worm Gearing, June, 1905; The Worm Gear, October, 1905, engineering edition; On the Location of the Pitch Circle in Worm Gearing, November, 1905.

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The worm should be long enough to allow the wheel to act on it as far as it will. The length of the worm required for this may be scaled from a carefully-made drawing, or it may be calculated by the following rule:

RULE 17. *To find the minimum length of worm for complete action with the worm-wheel, subtract four times the addendum of the worm thread from the throat diameter of the wheel, square the remainder, and subtract the result from the square of the throat diameter of the wheel. The square root of the result is the minimum length of worm advisable.*

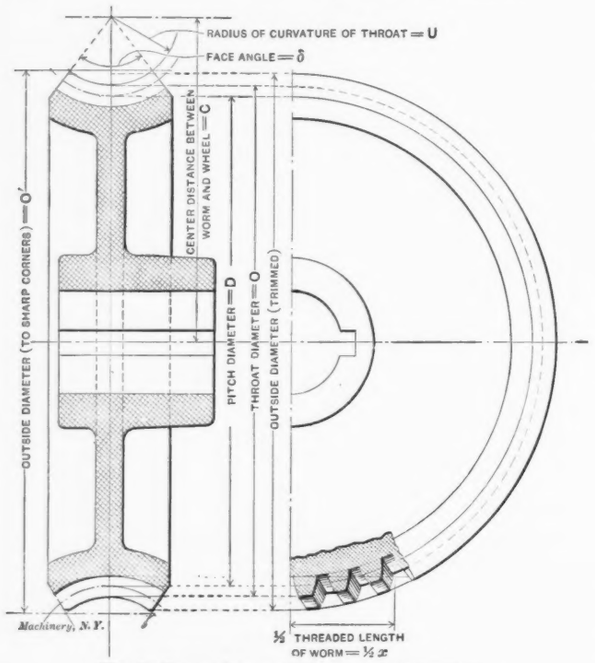
RADIUS OF CURVATURE OF THROAT = U
FACE ANGLE = δ
CENTER DISTANCE BETWEEN WORM AND WHEEL = C
OUTSIDE DIAMETER (TO SHARP CORNERS) = O'
PITCH DIAMETER = D
THROAT DIAMETER = O
OUTSIDE DIAMETER (TRIMMED)
½ THREADED LENGTH OF WORM = ½ x
Machinery, N.Y.

Fig. 3. Nomenclature of Worm-wheel Dimensions.

The length of the worm should ordinarily be longer than the dimension thus found. Hobs, particularly, should be long enough for the largest wheels they are ever likely to be called upon to cut.

Departures from the Above Rules Sometimes Advisable.

The throat diameter of the wheel and the center distance may have to be altered in some cases from the figures given by the preceding rules. If worm-wheels with small numbers of teeth are made to the dimensions given, it will be found that the flanks of these teeth will be partly cut away by the tops of the hob teeth, so that the full bearing area is not available. The matter becomes serious when there are less than 25 teeth in the worm-wheel. There are two ways of avoiding the difficulty. One of them is to increase the included angle of the sides of the thread tool. This departure from standard form, however, may be avoided by an increase in the throat diameter of the wheel, and consequently in the center distance. Discussions of this subject will be found in "Formulas in Gearing," and "Practical Treatise on Gearing," both published by the Brown & Sharpe Mfg. Co., Providence, R. I.

On the other hand, some designers claim to get better results in efficiency and durability by making the throat diameter of the worm-wheel *smaller* than standard, where it is possible to do so without too much under-cutting. For a discussion of this subject, see the articles by various writers, mentioned in the foot note on the preceding page. In no case, however, should the throat diameter ever be made so small as to produce more interference than is met with in a standard 25-tooth worm-wheel.

Two Applications of Worm Gearing.

Worm-wheels are used for two purposes. They may be employed to transmit power where it is desired to make use of the smoothness of action which they give, and the great reduction in velocity of which they are capable; instances of this application of worm gearing are found in the spindle drives of gear cutters and other machine tools. They are also used where a great increase in the effective power is required; in this case advantage is generally taken of the possibility of making the gearing self-locking. Such service is usually intermittent or occasional, and the matter of waste of power is not of so great importance as in the first case. Examples of this application are to be found in the adjustments of a great many machine tools, in training and elevating gearing for ordnance, etc. In the case of elevator gearing and worm feeds for machinery, the functions of the gearing are, in a measure, a combination of those in the two applications.

Examples of Worm Gearing Figured from the Rules.

To show how the rules given above may be applied, we will work out two examples. The first of these is for a light machine tool spindle drive, in which power is to be transmitted continuously. It is determined that the velocity ratio shall be 8 to 1, and that the proper linear pitch to give the strength and durability required shall be about ¾ inch; the center distance is required to be 5 inches exactly. This case comes under the first of the two applications just described.

Assume, for instance, 32 teeth in the wheel, and a quadruple-thread worm. We will figure the gearing with these assumptions, and see if it appears to have practical dimensions.

The pitch diameter of the worm-wheel by Rule 10 is found to be

$$\frac{32 \times \frac{3}{4}}{3.1416} = 7.6394 \text{ inches.}$$

The pitch diameter of the worm by Rule 16 is found to be

$$(2 \times 5) - 7.6394 = 2.3606 \text{ inches.}$$

The addendum of the worm thread by Rule 5 is found to be

$$0.3183 \times \tfrac{3}{4} = 0.2387 \text{ inch.}$$

The outside diameter of the worm by Rule 6 is found to be

$$2.3606 + (2 \times 0.3183) = 2.8380 \text{ inches.}$$

For transmission gearing the angle of inclination of the worm thread should be not less than 18 degrees or thereabouts, and the nearer 30 or even 40 degrees it is, the more efficient will it be. From Rule 1 we find the lead to be $4 \times \frac{3}{4} = 3$ inches.

The helix angle of the worm thread is found from Rule 9, $2.3606 \times 3.1416 \div 3 = 2.4722 =$ cot. 22 degrees, approximately. This angle will give fairly satisfactory results. The calculations are not carried any further with this problem, whose other dimensions are determined from those just found. In the following case, however, all the calculations are made.

For a second problem let it be required to design worm feed gearing for a machine to utilize a hob already in stock. This hob is double-threaded, ½ inch linear pitch, and 2½ inches diameter. The center distance of the gearing is immaterial, but it is decided that the worm-wheel ought to have

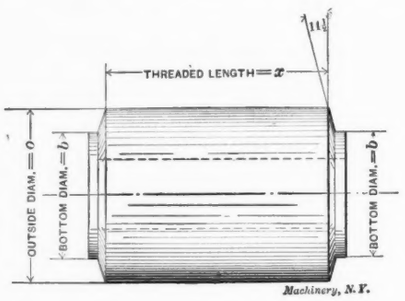

Fig. 4. Shape of Blank for Worm.

about 45 teeth to bring the ratio right. The only calculations made are those necessary for the dimensions which would appear on the shop drawing.

To find the lead, use Rule 1: $0.5 \times 2 = 1.0$ inch.

To find the whole depth of the worm tooth, use Rule 3: $0.5 \times 0.6866 = 0.3433$ inch.

To find the addendum, use Rule 5: $0.5 \times 0.3183 = 0.15915$ inch.

To find the pitch diameter of the worm, use Rule 7: $2.5 - 2 \times 0.15915 = 2.1817$ inches.

To find the bottom diameter of the worm, use Rule 8: $2.5 - 2 \times 0.3433 = 1.8134$ inch.

To find the gashing angle of the worm-wheel, use Rule 9: $2.18 \times 3.14 \div 1 = 6.849 =$ cot. 8 degrees 20 minutes, about.

To find the pitch diameter of the worm-wheel, use Rule 10: $45 \times 0.5 \div 3.1416 = 7.1620$ inches.

To find the throat diameter of the worm-wheel, use Rule 11: $7.1620 + 2 \times 0.15915 = 7.4803$ inches.

To find the radius of the throat of the worm-wheel, use Rule 12: $(2.5 \div 2) - (2 \times 0.15915) = 0.9317$ inch.

The angle of face may be arbitrarily set at, say, 75 degrees, in this case. The "trimmed diameter" is scaled from an accurate drawing, and proves to be 7.75 inches.

To find the distance between centers of the worm and wheel, use Rule 15: $(2.1817 + 7.1620) \div 2 = 4.6718$ inches.

To find the minimum length of threaded portion of the worm, use Rule 17: $7.4803 - 4 \times 0.15915 = 6.8437$

$$\sqrt{7.4803^2 - 6.8437^2} = 3.04 \text{ inches.}$$

It will be noted that the ends of the threads in Fig. 2 are trimmed at an angle instead of being cut square down, as in Fig. 1. This gives a more finished look to the worm. It is easily done by applying the sides of the thread tool to the

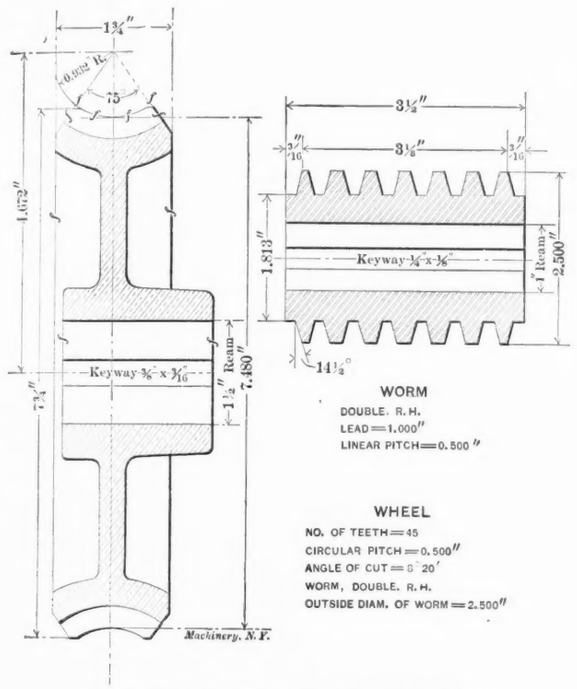

Fig. 5. Model Drawing of Worm and Worm-wheel.

blank just before threading, or it may be done as a separate operation in preparing the blank, which will in either case have the appearance shown in Fig. 4. The small diameters at either end of the blank in Fig. 4 should, in any event, be turned exactly to the bottom diameter shown in Fig. 2, and obtained by Rule 8. This is of great assistance to the man who threads the worm, as he knows that the threads are sized properly as soon as he has cut down to this diameter with the end of his thread tool. This always supposes, of course, that the thread tool is accurately made.

A model drawing of a worm-wheel and worm, properly dimensioned, is shown in Fig. 5. This drawing follows, in general, the model drawings shown by Mr. Burlingame in the August, 1906, issue of MACHINERY, taken from the drafting-room practice of the Brown & Sharpe Mfg. Co. In cases where the worm-wheel is to be gashed on the milling machine before hobbing, the angle at which the cutter is set should also be given. This is the same as the angle of worm tooth found by Rule 9. In cases where the wheel is to be hobbed directly from the solid by a positively geared hobbing machine, this information is not needed. It might be added that it is impracticable with worm-wheels having less than 16 or 18 teeth to gash the wheel, and then hob it when running freely on centers, if the throat diameter has been determined by Rule 11.

Formulas for the Design of Worm Gearing.

For the convenience of those who prefer to have their rules compressed into formulas, they are so arranged below. The reference letters used are as follows:

N = number of teeth in worm-wheel.
n = number of teeth or threads in worm.
P' = circular pitch of wheel and linear pitch of worm.
l = lead of worm.
g = whole depth of worm tooth.
t' = width of the thread tool at the end.
s = addendum or height of worm tooth above pitch line.
o = outside diameter of the worm.
d = pitch diameter of the worm.
b = bottom or root diameter of the worm.
β = helix angle of worm and gashing angle of wheel.
δ = face-angle of worm-wheel.
D = pitch diameter of the worm-wheel.
O = throat diameter of the worm-wheel.
O' = diameter of the worm-wheel to sharp corners.
U = radius of curvature of the worm-wheel throat.
R = velocity ratio.
C = distance between centers.
x = threaded length of worm.

$$l = n \times P'. \quad (1)$$
$$P' = l \div n. \quad (2)$$
$$g = 0.6866\,P'. \quad (3)$$
$$t' = 0.31\,P'. \quad (4)$$
$$s = 0.3183\,P'. \quad (5)$$
$$o = d + 2s. \quad (6)$$
$$d = o - 2s. \quad (7)$$
$$b = o - 2g. \quad (8)$$
$$\text{Cotangent } \beta = 3.1416d \div l. \quad (9)$$
$$D = N\,P' \div 3.1416. \quad (10)$$
$$O = D + 2s. \quad (11)$$
$$U = \tfrac{1}{2}o - 2s. \quad (12)$$
$$O' = 2(U - U\cos.\,\delta/2) + O. \quad (13)$$
$$R = N \div n. \quad (14)$$
$$C = (D + d) \div 2. \quad (15)$$
$$d = 2C - D. \quad (16)$$
$$\text{Minimum value of } x = \sqrt{O^2 - (O - 4s)^2}. \quad (17)$$

* * *

THE AUTOMOBILE AS THE PIONEER OF CIVILIZATION.

It is a curious fact that the automobile is put to its best practical use, as it seems, not in the countries of the highest development in civilization, but in the way-off corners of the world, where one would hardly expect to meet with so recent an indication of the presence of civilized man. Thus, in Madagascar there has been regular freight and passenger traffic over a route over 200 miles long, all since June, 1903. The motor cars use two days to cover the distance mentioned. Even in Tunis has a long-distance motor-car route been established, giving regular service over a line 80 miles long. The use of motor cars for this purpose is rather limited in this country, although they have been employed to some extent in the newly developed mining regions in the arid southwest, where there is considerable difficulty in the employment of animals, owing to the heat and lack of water. One of these routes, that connecting the Bull Frog and Goldfield mining districts with the nearest railroad station, adopted a novel scheme for monopolizing the highway built for the purpose. Over the gullies, which had to be bridged, the cars are run on stringers, with suitable guides to prevent them from running off. There is no flooring to these bridges, so that it is impossible for a horse-drawn vehicle to cross.

* * *

The *Times Engineering Supplement* gives some details about a remarkable garage, which are of interest mostly as indicative of the enormous growth the automobile business has had abroad for commercial purposes. The garage referred to is to be erected in London and is to accommodate 960 motor cabs. One of the most interesting details is the safety arrangement for the petrol or gasoline. While the building is built wholly of fire-proof materials, containing no wood, but only steel protected by concrete, the petrol storage, designed to contain 3,200 gallons, would in itself constitute an element of danger. This storage has iron doors and fireproof partitions, and the roof is so constructed that, were a fire to occur, a layer of sand weighing 62 tons would at once descend bodily and extinguish any fire in the petrol.

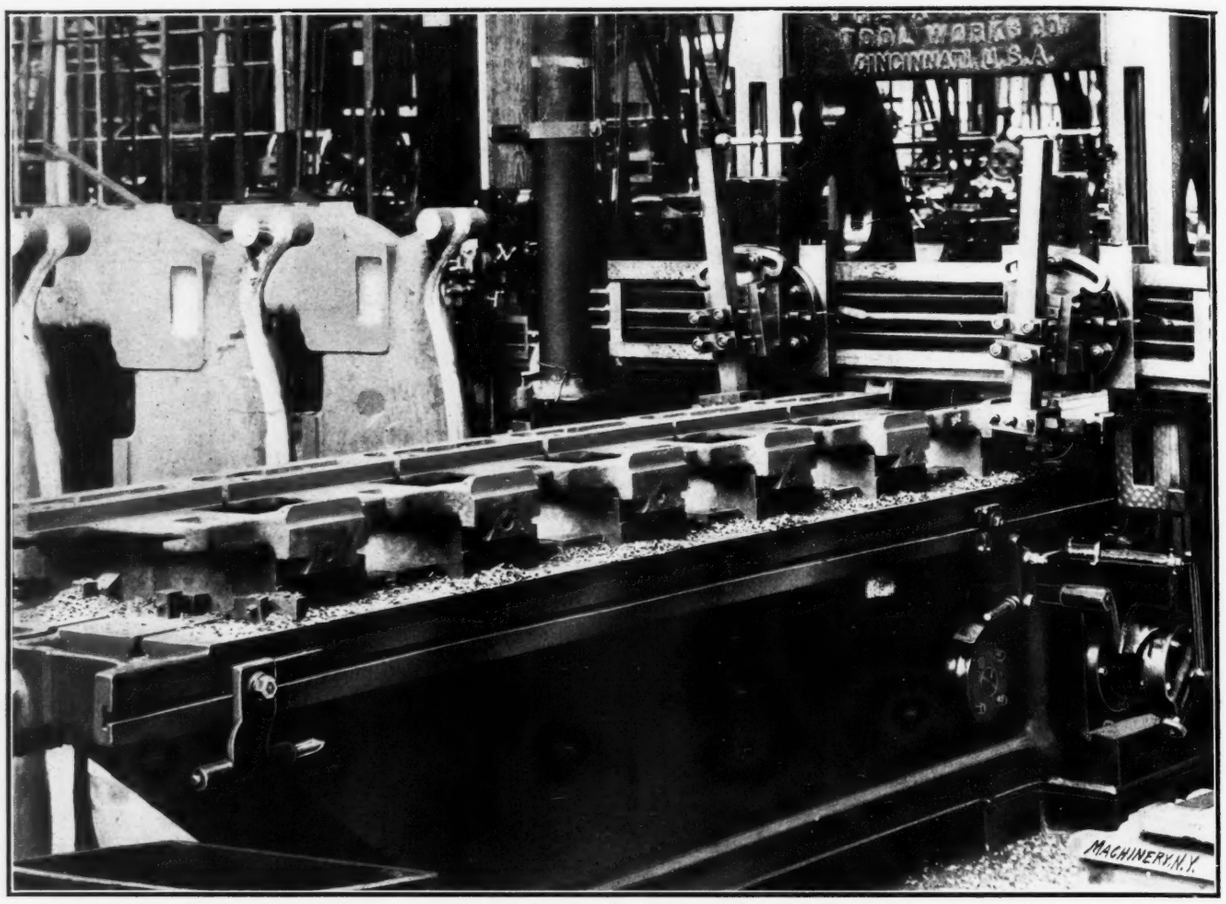

Fig. 1. Planing Lathe Saddles in Gangs.

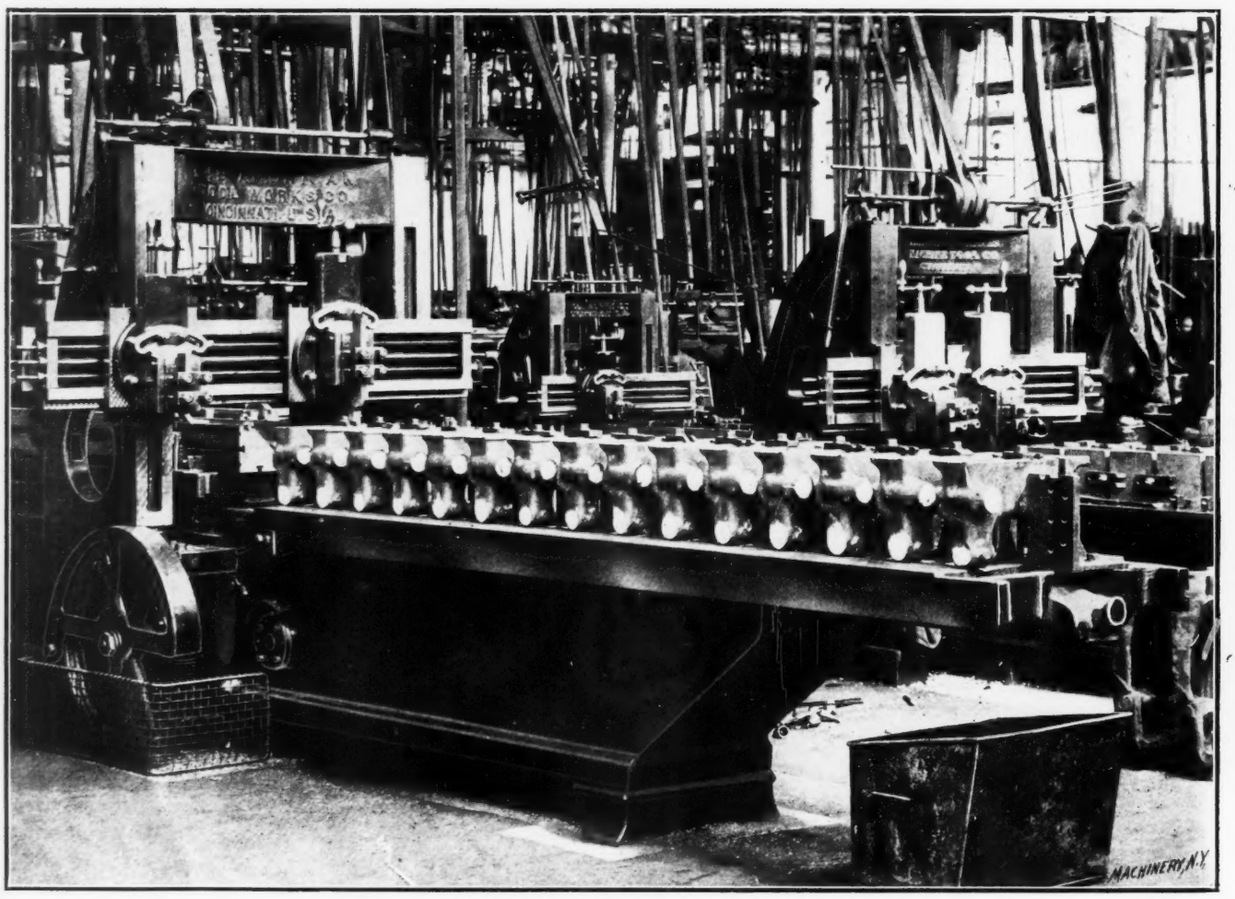

Fig. 2. Planing Aprons for the Saddles shown in Fig. 1.

ADVANCED BRITISH MANUFACTURING METHODS.

The accompanying half-tone illustrations show seven interesting examples of repetition work in machine tool manufacturing, taken from the well-known works of Alfred Herbert, Ltd., Coventry, England. In the March and April issues of MACHINERY half-tones were shown illustrating some structural features of the new Edgwick works of this concern at Coventry, which may be regarded as representative of advanced machine shop construction abroad. It will be admitted readily enough that the accompanying cuts, showing quantity production work, illustrate practice equal in most respects to the best methods pursued by leading American tool builders.

Fig. 1 shows the planing of lathe saddles in gangs of six, each casting being held in a dove-tail slotted jig in which the top guide of the carriage is chucked.

Fig. 2 shows the planer working on fifteen aprons for the lathe saddles illustrated in Fig. 1. In this case the aprons are simply chucked on the table using ordinary appliances, no jigs whatever being employed.

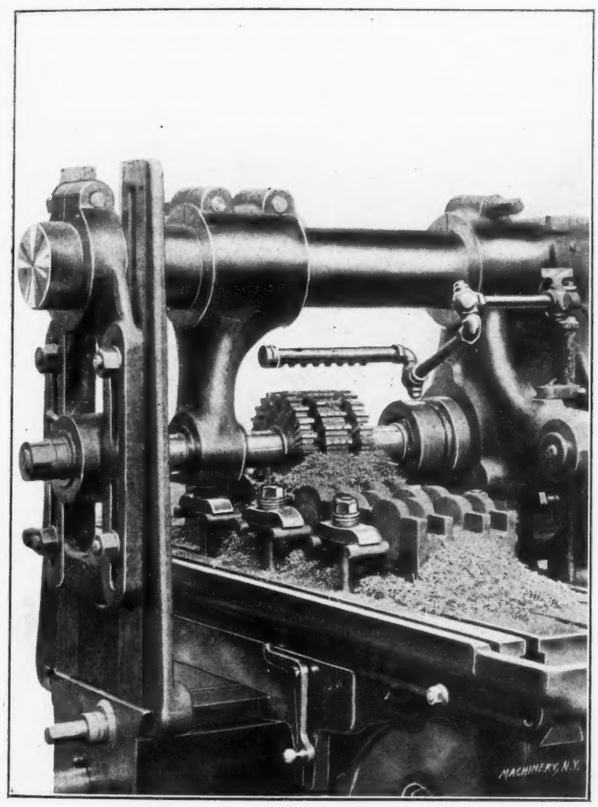

Fig. 3. Milling Toggle Levers for Turret Lathe Chucks.

Fig. 6 shows the planing of heads of small turret or "capstan" lathes, as they are known in British practice. In this operation fourteen heads are planed at once, two strings of seven each being ranged on the table. Here also there are no jigs used, as the nature of the work does not require it and, moreover, the irregularity of castings usually makes it the best practice to accommodate the casting to the finished requirements in the first operation, using the planed surfaces as gage points for determining the other dimensions in the succeeding operations.

Fig. 7 shows twenty-six cut-off slides for the Herbert hexagon turret lathe, these being in two strings of thirteen each. A large number of the slides are lying on the floor in front of the planer.

The same practice of grouping work in gangs is followed in milling machine work, and Fig. 3 is one illustration of the practice, showing the milling of toggle levers for the chuck of the Herbert hexagon turret lathe. Fig. 4 is an example of index milling, the work being the index disks for turrets. These are strung together on an arbor, and are indexed by the simple device shown on the front.

Fig. 5 illustrates the gang method of milling the conical holders used in the chuck of the Herbert turret lathe. In this case four saws are used at once and four holders are indexed simultaneously, the holders being held so that they are retained in position even after being slitted completely apart.

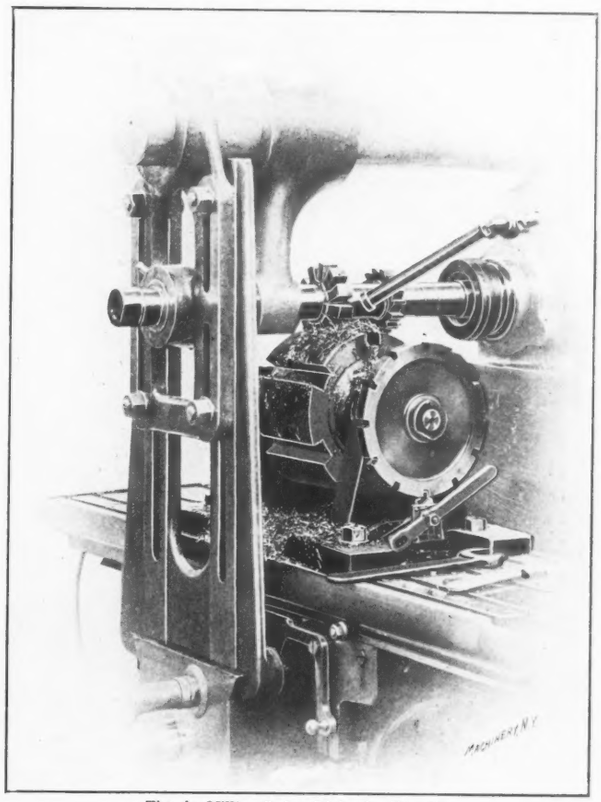

Fig. 4. Milling Index Disks for Turrets.

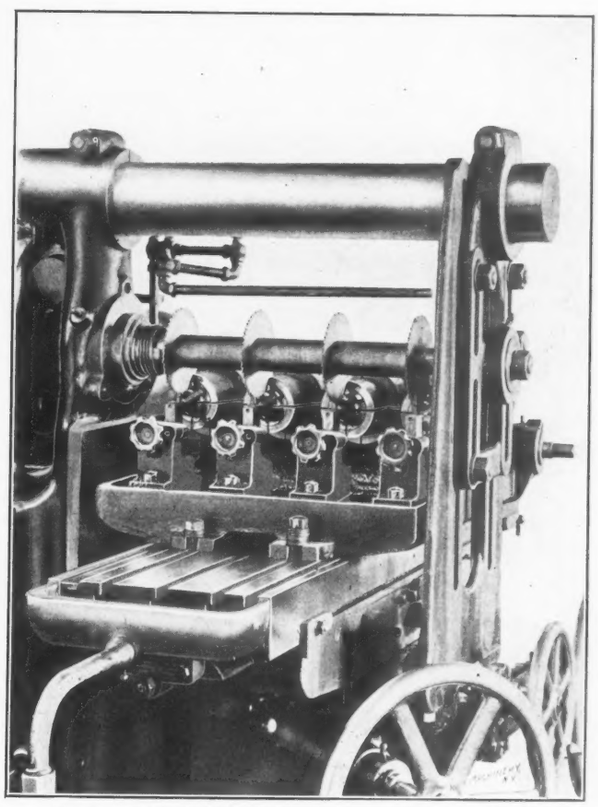

Fig. 5 Slitting Conical Holders used in Turret Lathe Chucks.

The pattern or "dummy" casting for setting planer tools, which is so much used in American practice on similar work, is not shown in use in any of these examples. This seems somewhat strange, for the use of the pattern is a great time-saver in the setting of the tools.

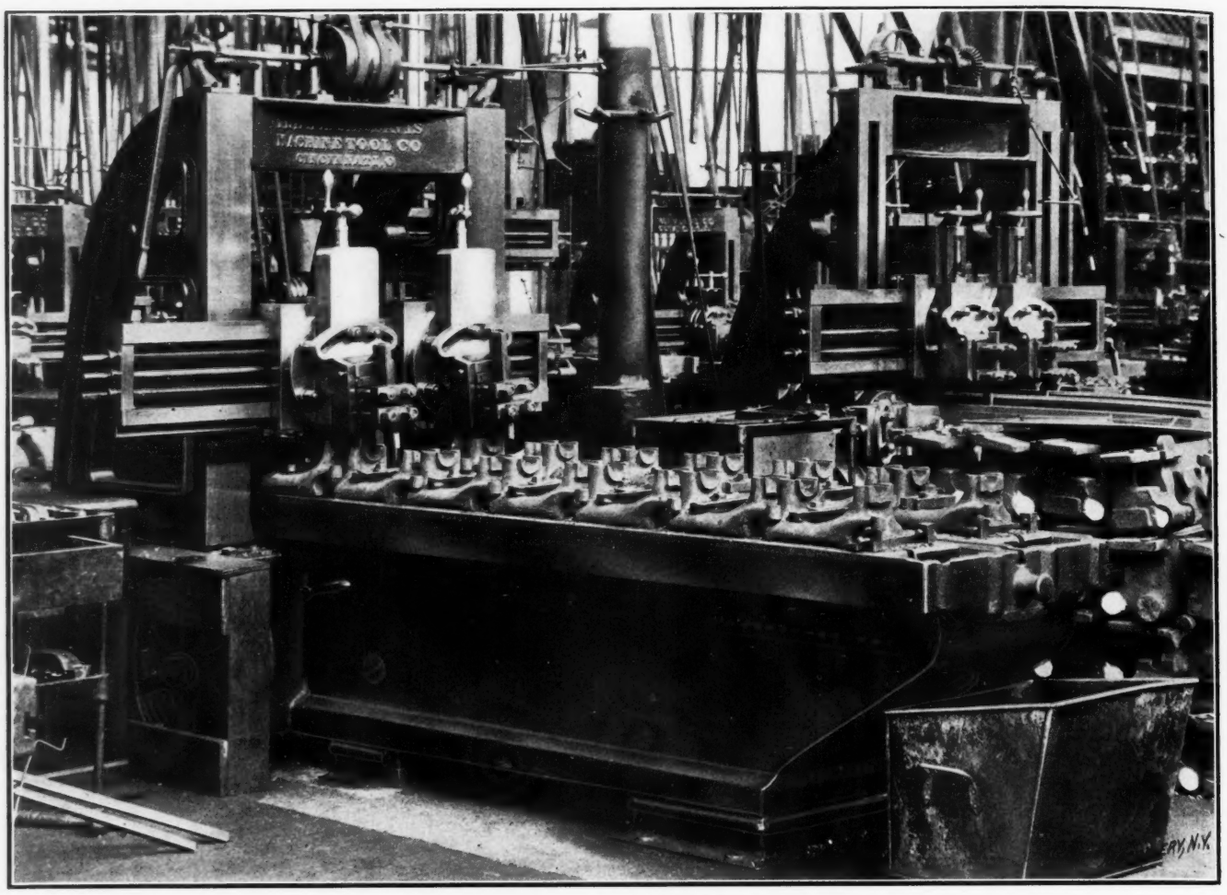

Fig. 6. Planing Heads for Small Turret Lathes.

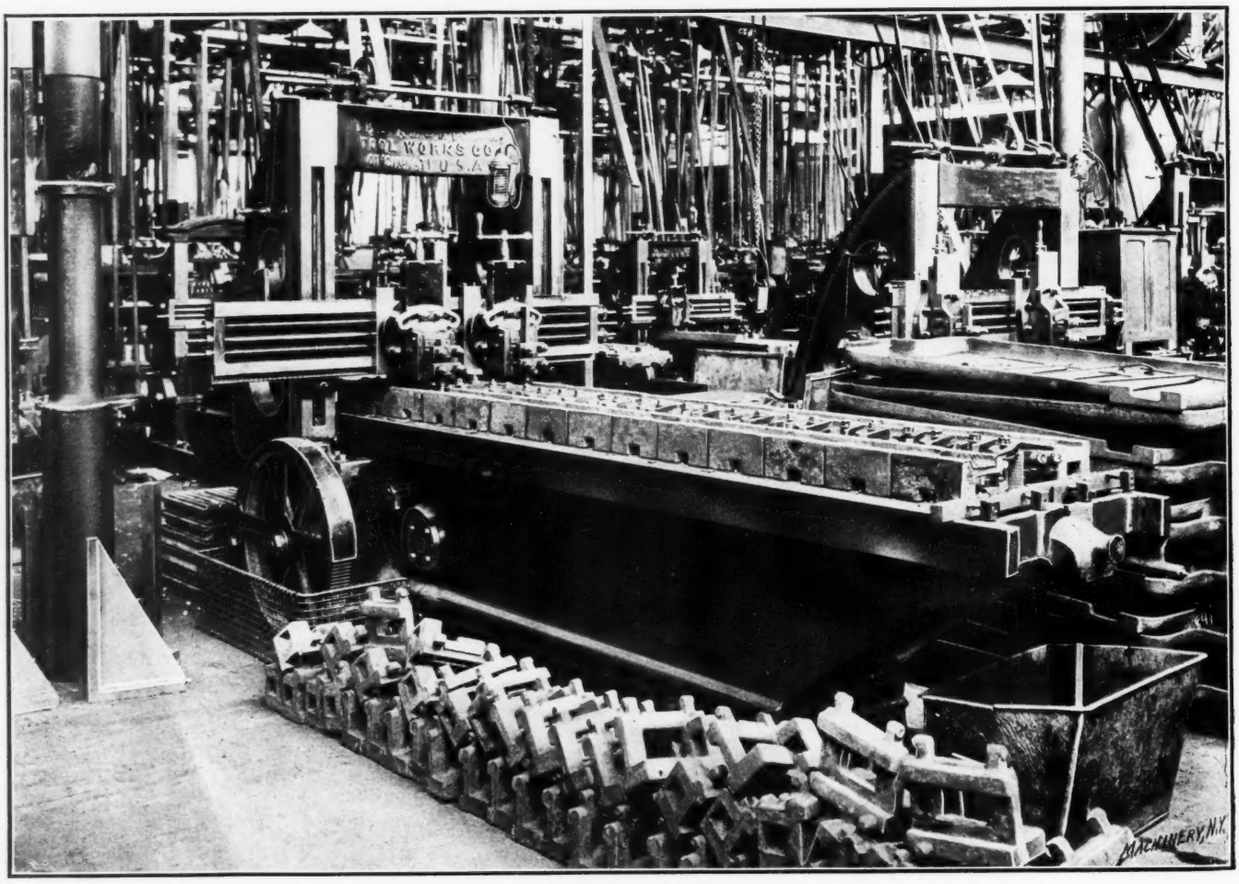

Fig. 7. Planing Cutting Off Slides for Turret Lathes.

ROTARY ENGINES.

W. H. BOOTH.*

Next to perpetual motion machines, the rotary engine is the favorite hunting ground of the born inventor. It often gives one a pang of regret to see the enormous ingenuity of the men who bring forth rotary engines, and yet only a fraction of the total number invented ever comes within one man's ken. I should be sorry to say how many I have seen in my time, but I well remember the first one which was brought to my notice by a man who had, as usual, put money into it. He could not describe it, but, of course, it differed from all that had hitherto been invented. Finally, when I saw it, it proved to be of the very familiar type of the Beale's exhauster with spring shutters that moved in and out as an inner solid cylinder rotated inside a hollow cylinder. It is of interest to know that Mr. Beale's gas exhauster was invented as a rotary engine, but proved a failure, as all of that stamp have done, and must do, but the inventor, or someone else, converted it into a gas exhauster for which purpose it is very suitable.

The first rotary engine which presented itself to me as really outside the ordinary type, was an uncommonly ingenious machine. The great trouble with rotary engines that have shutters is that there is so very much rubbing friction and so very little piston-generated volume. This the inventor sought to remedy. He placed a cylindrical steam admission valve inside the shaft of the rotor, and admitted steam through this hollow valve. He also revised and varied the cut-off by slightly varying the angular position of this cylindrical valve. It was very ingeniously contrived and was very well made. But the main part of the invention, that which reduced the distance moved by the shutters over the surface of the cylinder, was the elimination of most of the shutter friction, for the cylinder rotated nearly as fast as the inner rotor. The cylinder was carried in roller bearings and went round with the shutter. I do not clearly recollect the whole of the arrangement, but the rotor did not turn on the same center as the cylinder. They were slightly eccentric, and the difference of diameter was made up by shutters which were constantly kept pressed against the periphery of the cylinder. The rotor rolled on the cylinder; that is to say, it drove the cylinder around as if this was an inside gear driven by a pinion, but little smaller than the gear. This rolling contact gave to the rotor and cylinder exactly equal peripheral velocities. The peripheral velocity of the cylinder was, therefore, slightly less than that of the sliding shutters of the rotor, and these moved slowly over the cylinder with a speed that was represented by the ratio of the radius of the rotor body and of the shutter tips when out to their full extent. This movement was slow, perhaps a fourth or a fifth that of the ordinary shutter engine with fixed cylinder. The rotor was in perfect balance, and as the shutters went round with the outer cylinder this was in perfect balance also, though the two rotating bodies did not have the same center of revolution. A small engine appeared to work perfectly. It ran quietly at a very high speed, driving an electric generator in London, and it had no vibration troubles. All its parts were practically lathe finished, the rollers being cut off in lengths, and all was to gage and interchangeable. Where trouble could be seen ahead was in the valve. This internal valve had to stand still, and the rotor rotated upon it. Here was as much surface rubbing as had been gotten rid of in another part of the engine. It was not of serious moment in the small machine, but it bid fair to become serious in machines of larger size, and this point was realized by the inventor, for he considered it to be a suitable machine to form one end of a line of steam engines for which the larger sizes were to be turbines. I never heard what became of this engine, but it was about the best I ever saw, and had points in its small sizes that may have enabled it to live for certain fields of work, as for engines for small launches, or even for steam-driven commercial vehicles.

A neat rotary engine of noticeable excellence was one in which a bilobed rotating piece, similar to the rotor in a Root's blower, rotated eccentrically within a three-lobed casing or cylinder. The two rotating pieces, for the cylinder as well as the rotor proper rotated, were connected by a sort of inside sun and planet gearing which held them rigidly in correct relative positions. This little motor was shown driving a propeller in a glass tank, and it could be instantly and rapidly reversed by the simple movement of a lever. It was exceedingly ingenious and pretty, but it seemed to me that there might be trouble in time with the gearing, the stress upon which was heavy, for the work done on the shaft was the difference of the work done by the two moving parts, and the wheels had to carry a lot of interchange work. I am unable to recollect the valve gear sufficiently to describe it, but the whole engine was very simple and well made. There were, of course, the usual flat ends of the rotor to be kept steam tight against the cylinder.

The next engine of note was of a somewhat different order. A solid rotor cylinder rotated in a cylindrical case of about two or three inches larger radius. A projecting but non-sliding shutter closed the annular space. The problem was to get this piece round the cylinder, and yet to furnish an abutment for the steam to push against. To gain this end a rotary cylinder as large as the rotor was placed in a parallel cylinder and rolled upon the rotor, but it had a longitudinal gullet cut in its surface like the gullet in a Geneva winding stop, and the projecting shutter of the rotor coincided with this gullet at each revolution and thus got round its circle, the rotating valve or chuck cylinder closing the annular passage round the rotor as soon as the shutter or tooth had passed. The two rotors were kept in correct position by a pair of equal gears. What bid fair to make large engines clumsy was that the auxiliary rotor had to be of the same diameter as the rotor which had a rolling contact with it. The engine seen by me moved at a very high velocity and was exceedingly ingenious, but I felt obliged to tell my friend, who was proposing to finance it, that I had seen other rotary engines as good, and I did not know of any rotary engine at that moment that was enjoying a commercial life.

Now this is a fact of great moment to any young engineer who may run up against some form of rotary engine that is going to revolutionize everything. If his pet engine succeeds, let him bear in mind that it is the first one that has done so. What does this mean? It means that there is some practical difficulty that excludes these engines for commercial purposes. Possibly each one of the three engines I have described might find a field in some motor vehicle or boat, for in each case the weaknesses that seemed most apparent to me were not marked in the small sizes, and would only become very serious as dimensions and power increased. It was more or less distressing to know that some man had spent years of ingenuity on these little rotary engines. How do these rotary inventors live? Who finds the early cash to keep the engines afloat, and —if they ever do go to flotation with a secretary and a board of directors, what then becomes of them? They pass into oblivion. One does not see them about. Their users seem all to lie very low, and yet they are full of ingenuity, are often well made, and have gone through a lot of development. But they seem all to be too much tied as to dimensions. They have inherent difficulty for larger sizes, and there seems to be something in the rotary principle which circumvents the most ingenious method of the inventor. The chief trouble, I take it, is the small cylinder volume per unit of piston rubbing surface. Then there is the flat end of the rotor, which has to be kept tight, and so on through other details which perhaps help to explain why so many are called and none are chosen.

* * *

The construction followed in tall office buildings of New York and other cities has an important effect on the insurance rates. The "Caledonian," a new building recently erected in Pine Street, New York, carries an insurance rate of only 50 cents per $1,000. The building has a cast iron frame protected by porous terra-cotta and brick, and is twelve stories high. In contrast to this is a ten-story building in Broad Street, not far from the New York Stock Exchange, which pays twice as much, or $1.00 per $1,000. The addition in rate is because the metal frame is not protected by either terra-cotta or brick.

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REAMERS.—1.

ERIK OBERG.*

Reamers, in the narrowest sense of the word, include only tools intended for producing a hole that is smooth and true to size. In a wider sense, however, the word is applied to any solid circular tool, with a number of cutting edges, used for enlarging cored or drilled holes, little or no account being taken of whether the resulting hole is strictly true to size or not. With reference to the manner in which the reamers are made, we may distinguish between solid and inserted blade reamers. The latter are usually adjustable for size. With reference to the purpose of reamers, and the manner in which they are used, we distinguish mainly between hand reamers, chucking reamers, shell reamers, and taper reamers. The latter class of reamers is mostly, perhaps, used by hand, the same as the hand reamer, but the hand reamer is considered to mean only a straight reamer, and the taper reamer forms a class by itself. On the boundary between reamers and drills is the grooved chucking reamer, which is used for roughing cored holes, and is fluted with spiral grooves like a twist drill. Center reamers constitute a special class of reamers, which are used for reaming the centers in pieces to be held between the centers in the lathe.

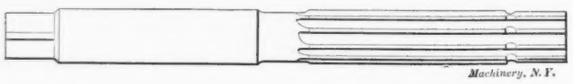

Fig. 1. General Appearance of Hand Reamer, with Guide.

Hand Reamers.

The ordinary hand reamer, provided with guide, is shown in Fig. 1. As seen from the cut, it consists of a cutting portion, a shank, and a square by which it is turned when in use. As is also shown, the end portion of the shank on which the square is formed is turned down below the diameter of the shank proper. The purpose of this is to prevent any burrs that may be raised on the edges of the square by the wrench, by which the reamer is turned, from projecting outside of the diameter of the shank, thus either preventing the reamer from being drawn clear through the hole reamed, or causing scratches in the hole if the reamer be pulled through. Between the cutting portion and the shank there is a short neck, the purpose of which is, primarily, to provide for clearance for the grinding wheel when grinding the cutting edges as well as the shank of the reamer, and also to permit the cutter by which the flutes are cut to clear the shank so as to give a more finished appearance to the tool. The main requirements placed on a hand reamer are that it shall be able to produce a smooth, a straight, and a round hole. The first of these requirements may be obtained in either of three ways: By giving the reamer an odd number of flutes; by fluting the reamer with spiral flutes; or by giving an even number of flutes, but placing these at irregular intervals on the periphery of the reamer. This latter practice is at present the most common one, and is employed by leading manufacturers of reamers. The uneven spacing of the cutting edge is termed "breaking up the flutes," and is the simplest and most effective way of making a reamer which will produce a smooth hole.

For obtaining a straight hole, the reamer should be provided with a guide. This provision is not generally made in reamers manufactured for the market, but is one of great importance in a tool that is expected to produce accurate work. The requirements mentioned are discussed at length in an article on hand reamers in the January, 1906, issue of MACHINERY.

Relief.

It will also be necessary to remark that giving too much or too little relief to a reamer will tend to produce unsatisfactory results. Too much relief invariably causes a reamer to chatter. Too small relief, again, will wear the reamer more, as the shavings get in between the cutting edges and the work to be reamed and slowly grind away the land; besides, there is a tendency to bind the reamer in the hole, with the consequent results of injuring the hole as well as the reamer, and causing the expenditure of more exertion in performing the reaming operation.

In this connection it might be mentioned that the flat relief, although mostly used, is not the most desirable, nor the ideal one, because the cutting edge is not properly supported. The best results are obtained by a relief as shown in Fig. 2. The difference between this relief and the flat is very obvious from the cut, where the latter relief has been shown in dotted lines. This special relief, usually termed the eccentric relief, is used only by two prominent tool manufacturers, but it is to be strongly recommended, because it adds greatly to the reamer's capability of producing a smooth hole. The relief is produced by placing the reamer in a grinding machine, as usual, but not on centers in line with the spindle, but on auxiliary centers, provided with adjustment sideways, so as to enable them to be set at different positions for different relief wanted on different sizes and kinds of reamers. The reamer is thus held eccentrically. A rocking motion is then imparted to the spindles holding the auxiliary centers, and in this manner the grinding wheel, traveling forth and back along the reamer, will produce an eccentric relief.

This eccentric relief, however, is not in favor with all users of reamers. The eccentrically relieved reamer is purely a finishing reamer, and cannot with advantage be used to remove any considerable amount of metal, because it has practically a negative rake. When hand reamers are used merely for the purpose of removing stock, or in other words, simply for enlarging holes, the flat relief will undoubtedly prove to be superior to the eccentric. The primary use of straight hand reamers, however, is for producing holes true to size and smoothly finished, removing meanwhile but a small amount of stock. For this purpose nothing excels the eccentric relief. That there is a distinct difference between the relief required, according to the use to be made of the reamer, is best proved by the fact that, while some manufacturers of tools always relieve their reamers eccentrically, intending them to be used as finishing reamers, some of their customers, after receiving an order, place the reamers in a grinding machine and replace the eccentric relief with a flat one, because they find this relief better for their purposes, *viz.*, simply enlarging holes, irrespective of the highest requirements of accuracy and smoothness.

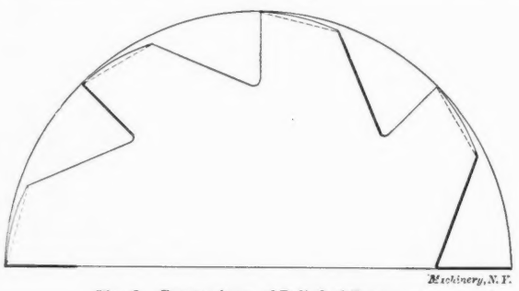

Fig. 2. Comparison of Relief of Reamers.

Reamers with Helical Flutes.

Although the advantages of helical, or, as it is commonly called, spiral cutting edges are somewhat doubtful for straight reamers for ordinary use, they are recommended for such work where the hole reamed is pierced crosswise by openings. A right-handed reamer should have left-hand spiral flutes, in order to prevent the tool from drawing into the work. The angle of spiral should be such that the cutting edges will make an angle of 15 degrees with a plane passed through the axis of the reamer. The number of flutes may be the same as if the reamer were provided with straight cutting edges, and the same kind of fluting cutters are employed.

Threaded-end Hand Reamers.

Hand reamers are sometimes provided with a thread at the extreme point in order to give them a uniform feed when performing the reaming operation. The diameter on the top of this thread at the point of the reamer is considerably smaller than the reamer itself, and the thread tapers upward until it reaches a dimension of from 0.003 to 0.008 inch, according to

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size, below the size of the reamer; at this point the thread stops, and a short neck, about 1/16 inch wide, separates the threaded portion from the actual reamer, which is provided with a short taper from 3/16 to 7/16 inch long, according to size, up to where the standard diameter is reached. In fact, the reamer has the appearance of the regular reamer in Fig. 1, excepting that the guide is threaded and tapered.

The length of the threaded portion, and the number of threads per inch with which to provide the point, are given below:

Size of Reamer.	Length of Threaded Portion.	No. of Threads per inch.
From 1/8 to 5/16 inch	3/8	32
From 11/32 to 1/2 inch	7/16	28
From 17/32 to 3/4 inch	1/2	24
From 25/32 upward	9/16	18

The kind of thread employed is the sharp V-thread, as this thread gets a better grip on the metal, and thus feeds the reamer in a more certain manner.

The diameter measured over the top of the thread at the end of the point of the reamer should be as follows:

Size of Reamer.	Diameter of Thread at Point of Reamer.
From ⅛ to ½ inch	Standard size—0.006 inch
From 17/32 to 1 inch	Standard size—0.008 inch
From 1 1/32 to 1½ inch	Standard size—0.010 inch
From 17/32 to 2 inches	Standard size—0.012 inch
From 2 1/32 to 2½ inches	Standard size—0.015 inch
From 2 17/32 to 3 inches	Standard size—0.020 inch

Number of Flutes.

The following table gives the number of flutes with which hand reamers should be provided. It will be noticed that even the smallest sizes are provided with six flutes. It is not considered good practice to make hand reamers with a smaller number of flutes, if good results are expected from the use of the tool.

TABLE I. NUMBER OF FLUTES IN HAND REAMERS.

Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.	Size of Reamer.	Number of Flutes.
⅛	6	⅞	8	1¾	10
¼	6	1	8	2	12
5/16	6	1⅛	8	2¼	12
⅜	6	1¼	10	2½	14
7/16	8	1⅜	10	2¾	14
½	8	1½	10	3	16

From the table above it will be seen that the pitch of the teeth, or the distance from cutting edge to cutting edge around the circumference of the reamer increases from about ⅛ inch for a ¼-inch reamer, to about 9/16 for a 3-inch reamer. The pitch of the cutting edges for a 1-inch reamer is about ⅜ inch, and for a 2-inch reamer slightly more than ½ inch.

Fluting Cutters for Reamers.

Often the same kind of fluting cutters as are used for hand taps are employed for reamers also. The reamer, however, does not remove the same amount of metal as does the tap, and consequently there is no need for the same amount of chip room. The radius in the bottom of the flute is made smaller, because the flute, being made shallower, does not take away so much of the strength of the reamer, and consequently the reinforcement in form of a liberal round in the bottom of the flute is not necessary. Besides, the flutes on very small reamers are so shallow that a comparatively large radius on the fluting cutter would give too great a negative front rake to the teeth.

Figs. 3 and 4 give the usual forms of reamer fluting cutters. Fig. 3 shows a cutter of the same kind as used for taps, but with a smaller radius *D*. This class of cutter is used for smaller size reamers, say, up to 1¾ inch diameter inclusive, while the cutter, Fig. 4, is used for larger sizes. The included angle between the cutting faces of the cutter is 85 degrees in both cases, the same as for tap fluting cutters, but while the cutter, Fig. 3, has one face making 55 and the other 30 degrees with a line perpendicular to the axis of the cutter, in the cutter, Fig. 4, these angles are 70 and 15 degrees, respectively.

In Table II are given the dimensions commonly employed for these cutters, and the corresponding sizes of reamers for which they are used.

Setting the Cutter for Fluting.

When setting the cutter for fluting hand reamers, it should be set so that the tooth gets a slight negative rake, that is, the cutter should be set "ahead" of the center as shown in

TABLE II. FLUTING CUTTERS FOR REAMERS.

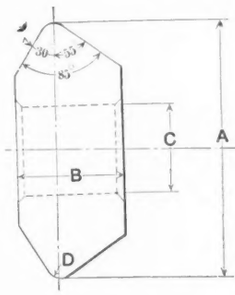

Fig. 3.

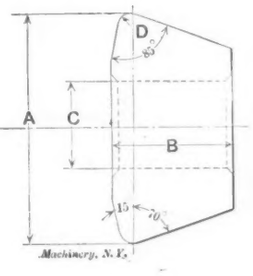

Fig. 4.

Diameter of Reamer.	Diameter of Fluting Cutter.	Thickness of Fluting Cutter.	Diameter of Hole in Cutter.	Radius between Cutting Faces of Cutter.
	A	B	C	D
⅛	1⅛	3/16	⅛	sharp corner, no radius.
3/16	1⅛	3/16	⅛	sharp corner, no radius.
¼	1⅛	3/16	⅛	1/64
⅜	2	¼	⅛	1/64
7/16	2	5/16	⅛	1/32
½	2	5/16	⅛	1/32
¾	2	7/16	¼	3/64
1	2¼	½	1	3/64
1¼	2¼	9/16	1	1/16
1½	2¼	5/8	1	1/16
1¾	2¼	5/8	1	5/64
2	2½	⅝	1	5/64
2¼	2½	⅝	1	5/64
2½	2½	¾	1	3/16
2¾	2½	¾	1	3/16
3	2½	1	1	3/16

Fig. 5. The amount to set the cutter ahead should be so selected that the angle included between the front face of the tooth and the tangent to the circumference of the reamer at the point representing the cutting edge is 95 degrees (see Fig. 5). A reamer will cut smoother if the cutting edge of the tooth has a negative rake than it will if the front face of the tooth is radial.

In Table III the dimension *a*, Fig. 5, or the amount to set the fluting cutter ahead of the radial line, is given. The figures in Table III give the angle *A B C* approximately 95 degrees, as mentioned. There may be objections raised to

TABLE III. TABLE FOR SETTING FLUTING CUTTERS FOR REAMERS.

Size of Reamer.	*a* (See Fig. 5) inches.	Size of Reamer.	*a* (See Fig. 5) inches.	Size of Reamer.	*a* (See Fig. 5) inches.
¼	0.011	⅞	0.038	2	0.087
⅜	0.016	1	0.044	2¼	0.098
7/16	0.022	1¼	0.055	2½	0.109
½	0.027	1½	0 066	2¾	0.120
¾	0.033	1¾	0.076	3	0.131

setting the fluting cutter as much as ⅛ inch ahead of the radial line for 3-inch reamers, but inasmuch as the angle of negative rake remains the same as for smaller sizes, there is no good reason why this amount should be made any smaller than given in the table.

The depth of the flute should be such that the width of the land of the tooth is about one-fifth of the average distance from the cutting edge of one tooth to the cutting edge of another. Should it not be as deep, there will not be sufficient space in the grooves to hold the shavings. Should it be deeper, the strength of the tooth will be impaired, and the cutting edge is likely to spring out when taking the cut, pro-

ducing a hole larger than the reamer. The difficulties encountered in milling the flutes on unequal distances, or breaking up the flutes, as it is commonly termed in the shop, are that, if all the grooves are milled to the same depth, the remaining land evidently will be wider in the case where the distance from cutting edge to cutting edge is larger than it will be in the case where this distance is smaller. To overcome this it would, of course, be possible to mill the flutes deeper between the cutting edges which are farther apart to insure that the width of the land would be equal in all cases. That this is impracticable when fluting reamers in large quantities is easily apprehended, as it would necessitate raising or lowering the milling machine table for each flute being cut. The width of the land will, therefore, vary somewhat when the flutes are "broken up," but of uniform depth. For a more thorough discussion of this matter see MACHINERY, October, 1899, "Irregularly Spaced Reamers," and February, 1907, "New Method of Milling the Flutes of Reamers."

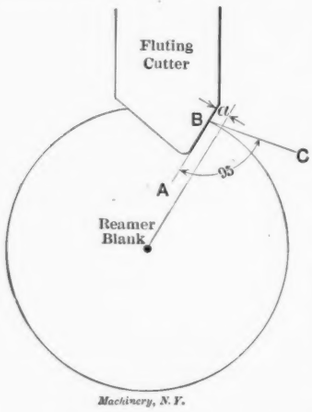

Fig. 5. Setting the Cutter for Fluting.

Precautions in Hardening Reamers.

If the reamers to be hardened are larger than ¾ inch in diameter they should be held over the fire immediately after being taken from the hardening bath, in order to as much as possible remove the strains caused by the hardening process. Another method is to remove the reamer from the water bath as soon as it stops "singing" and plunge it immediately into an oil bath, allowing the tool to stay in the oil until its temperature has been reduced to that of the oil. The temper should be drawn to 370 degrees F. If reamers spring in hardening they are heated slightly, and pressure applied to the convex side, the reamer being held between centers in the same manner as in a lathe. This same method is applied to long taps and to counterbores and drills.

* * *

A paragraph in the *Electrical Review*, June 8, 1907, gives an idea of the refinements necessary in experimenting with some of the new problems brought out by the discovery of radium and other radio-active substances. A paper recently read before a German technical society was said to be interesting on account of the "emphasis which it put upon the necessity of avoiding every possible source of error in the study of this new and striking branch of physical science. With the material sealed within a glass vessel, there was an apparent change in weight easily measured in a balance. This seemed at first good evidence of a loss of weight, as the tube became lighter; but the difference in weight was finally found to be caused by the changes in temperature of the tube and its contents, due to the chemical changes going on within it. This increase in temperature, by causing a slight increase in the volume of the tube, decreased its specific gravity, and thus gave rise to the apparent change in weight. When the tube had come to a stable condition and reached its original temperature, the weight was found to be identically what it had been when the tube was sealed up. Thus, it will be seen that all apparent effects may not be real, no matter how carefully the observations were made, and whenever they are in disagreement with our fundamental ideas of physics and chemistry, they should be scrutinized closely and put to every possible test. The new phenomena are puzzling enough, and are changing our ideas of matter rapidly. There is therefore all the more need to be careful."

* * *

In the hot hereafter, prick-punch fitters have a special place reserved.

AUTOMATIC NEEDLE-MAKING MACHINERY.

The accompanying photographs, Figs. 1 and 2, and line drawings, Figs. 3 and 4, show an interesting machine built by the Langelier Mfg. Co., Providence, R. I., for finishing sewing machine needles after they have been formed to shape on a rotary swaging machine of special design adapted to this particular class of product. The machine takes the swaged needle, which is fed into a magazine, cuts it to length, mills the grooves on the sides, perforates the eye for the thread, and rolls the number and name of the maker, if required, upon the shank. The four functions of the machine are performed automatically, and because of this combination, if nothing more is conceded, it constitutes an interesting example of machine design which does what a number of machines are ordinarily required to do.

In this connection, it is interesting to note that needle manufacturing is one of the oldest arts, and that its machinery, though primitive, was ingenious and interesting, being among the earliest examples of special machinery used in the metal-working arts. Needles were made from steel wire, being cut from the coil without straightening, this having to be done individually for each pair of needles, it being the practice to

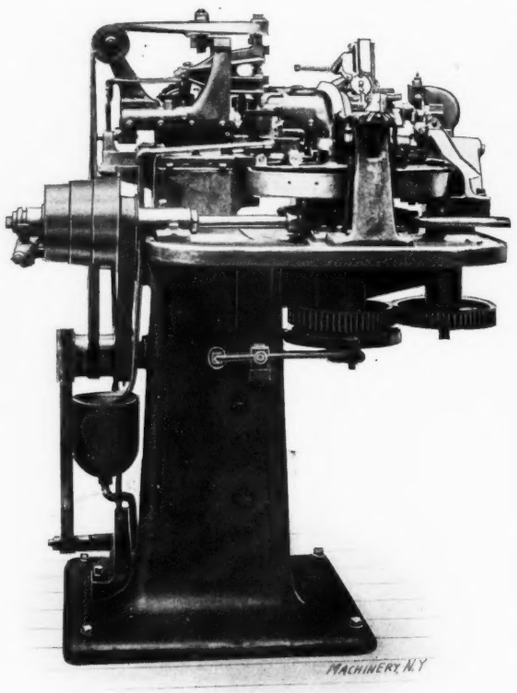

Fig. 1. Langelier Needle-making Machine, Magazine Side.

make them two together, with the eyes in the center. For many years the needle-makers of Redditch, England, held a practical monopoly of the business of making hand sewing needles, but in after years German needle-makers sprung up who became active competitors, many workmen from England being imported to Germany to teach the art. The machinery of these older needle-makers, of course, was of a very primitive design, and it was all of the unit type, each machine being designed for one operation, and each required the superintendence of a workman for its operation, and the same condition largely exists still in European needle manufacture. In this country the manufacture of needles and similar products is largely done by special machinery, developed by the manufacturers or built to order by makers of special machinery. In Europe, a manufacturer who intends to go into this line of business expects to buy the machinery for it in the open market. The difference comes about, of course, from the fact that American manufacturers generally act upon the principle of reducing the labor cost to a minimum, while the European makers do not strive so much to reduce labor cost as to have machinery that is of a so-called standard type and of simple

and cheap construction. The machine illustrated may, therefore, be regarded as a development of the American idea of making a machine that combines within itself a number of functions, which are automatically performed from start to finish without the interposition of manual labor.

The line drawing, Fig. 3, shows a plan view of the machine, which is another adaptation of the turret principle in machine design. The needles are thrown into a magazine *F*, where they drop into the longitudinal slots of a revolving truncated cone-shaped receiver and undergo the first operation at *A*, which is cutting to length. Each needle in turn then drops from the receiver into the slot of a horizontal reciprocating trough that in itself contains the necessary mechanism for accurately loading each of the chucks as they arrive in position opposite the trough. At no time are the needles out of control of the mechanism. The turret then indexes the needle one-quarter turn and brings it opposite the grooving machine *B*, which consists of two vertical spindles carrying angular milling cutters. These work through narrow slots in a suitable grooved receiver, which holds the needle firmly in position while the cutters work on the opposite sides of the needle and produce the grooves required for the protection of the

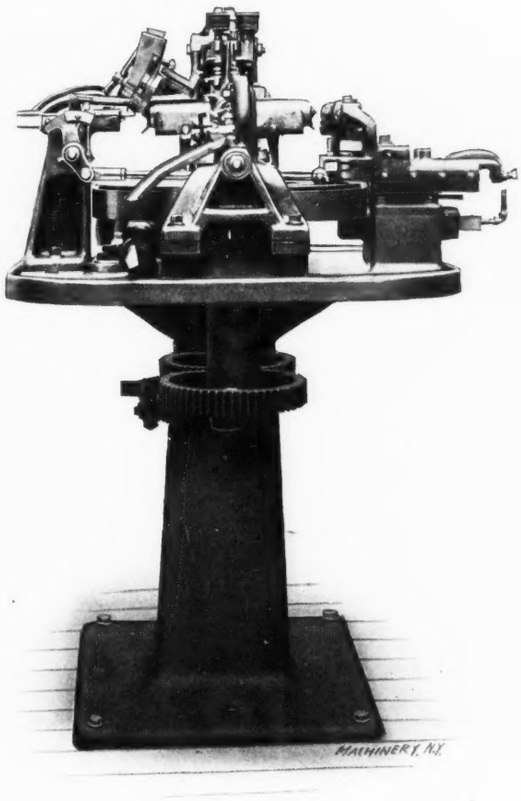

Fig. 2. Needle-making Machine, showing Numbering and Lettering Head in Front.

thread when penetrating the cloth. One side of a needle has a longer groove than the other, and this difference in length is automatically effected by the mechanism. When the grooving has been completed, the turret again indexes to the third position, *C*, where a punch automatically perforates the eye. The distance of the eye from the point is regulated by the screw *E*. The punches vary, of course, in thickness and width, according to the size of the needle and the size of the thread to be used. One size punch in common use, for example, is 0.032×0.014 inch. From this position, the turret again shifts the needle to the fourth position, *D*, where the number of the needle is automatically imprinted upon the shank, thus completing the functions of this machine. It should not be concluded, however, that the needle after leaving the machine is practically completed. Far from it. It still has to be pointed, the eye has to be polished out so as to let the thread slip easily, and the whole needle has to be polished, besides going through a number of minor operations, but the four operations performed by this machine are, with the exception of the pointing, the principal ones that have to be done after it is swaged to form.

An interesting feature of design of this machine is the cam-plate *G*, Fig. 4, by which the functions of the turret operating tools are controlled. This cam carries two races on its upper side and one on the lower side. The compound race on the

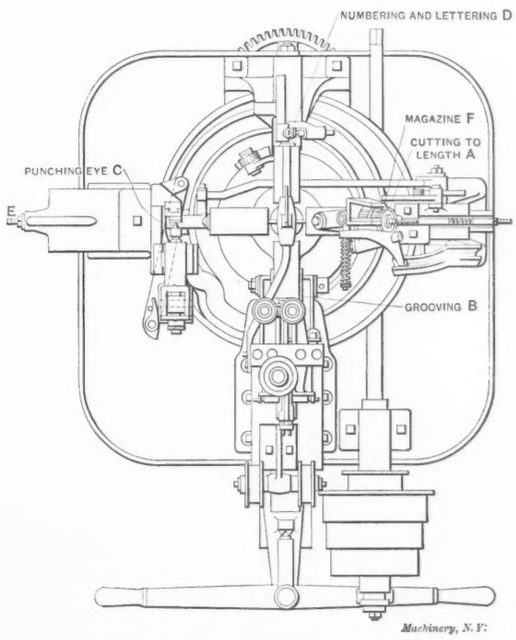

Fig. 3. Plan of Needle-making Machine.

upper side effects among others the pretty operation of controlling the feed-to-depth motion of the milling cutters and the longitudinal feed as well. This came is in continuous motion, being driven by the worm-wheel *H*. The turret is actuated by a segment gear, attached to the under side of the cam-plate, which engages the pinion *L* and actuates the turret through gears *M* and *N*.

The half-tone, Fig. 5, shows a view looking toward the faces of the swaging heads of the three-head rotary swaging machine which makes the needle blanks ready for the machine just described, and Fig. 8 shows the reel, wire straightening rolls, and a portion of the swaging machine, taken from the

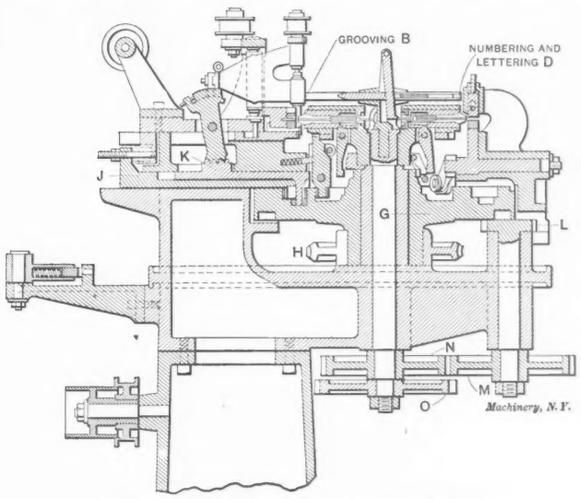

Fig. 4. Section through Needle-making Machine.

same side as shown in Fig. 5. Figs. 6 and 7 show the successive steps of the operations of swaging, grooving and piercing of the needle. The automatic swaging machine takes the wire from the coil, straightens it, cuts off the blank from the wire by a milling operation and swages it to shape in three operations, the blanks being fed successively, by a four-chuck turret having a horizontal axis, to the three heads of

the machine. The design of the machine is positive. The principle of keeping the blank always within the control of the machine is carried out the same as in the grooving and eyeing machine, the blank being continually within the grasp of the chucks until the three swaging operations are completed.

The swaging heads are made on the same principle as that employed in the regular Langelier machine, which was shown,

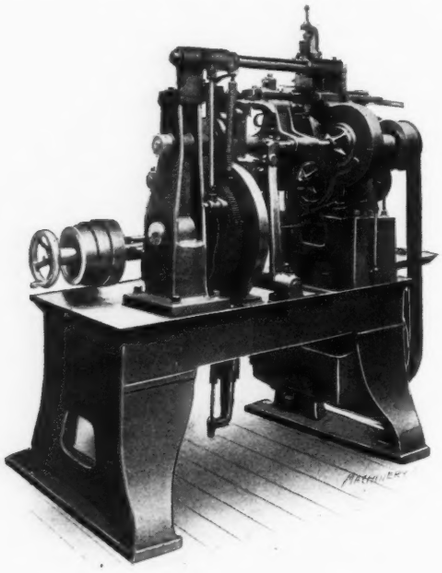

Fig. 5. Machine for Making Needle Blanks.

with interesting examples of work produced, in the May, 1903, issue of MACHINERY. Briefly, the construction consists of an outside stationary head of heavy construction in which there is an axial hole for the rotating head. The rotating head carries two dies in a radial slot. These dies tend to fly outward under the influence of the centrifugal force when rapidly rotating. Around the inner circumference of the hole in

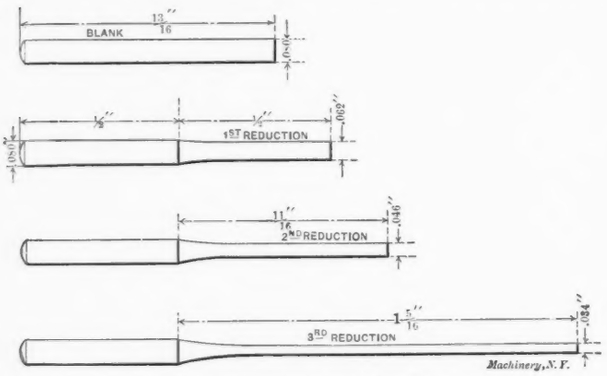

Fig. 6. Successive Steps in Swaging.

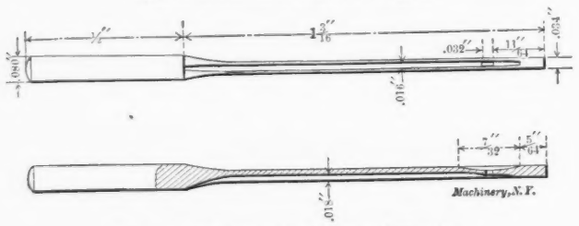

Fig. 7. Operations of Grooving and Piercing.

the stationary head there are located eight steel rolls with which the ends of the rotating dies come in contact as they turn, thus throwing them to the center. During one rotation of the revolving head the dies are forced together eight times, hence the wire receives eight times as many blows per minute as the number of rotations. The result of thousands of blows delivered in so short a time is a very rapid action in reducing wire stock to any required form.

NOTES ON CAM DESIGN AND CAM CUTTING.*

JAMES L. DINNANY.†

James L. Dinnany.‡

It is strange that the processes and methods of cam cutting have not been improved more rapidly than they have. Twenty-five years ago, in the first shop I worked in, cams and gears were on about an equal footing; that is to say, most of both were cast to as nearly the proper shape as possible, after which the working surfaces or teeth were smoothed up with a file, and then the holes and hubs were finished in the usual manner. Some cams of both plate and barrel forms were cut, with suitable attachments, in the same machine the gears were cut in. This was an old hand indexing machine, with an automatic feed composed of a weight hung on the pilot wheel. Since that time gear cutting machinery has been wonderfully developed. All sorts of styles and arrangements are on the market, meeting every demand, from that for a general purpose machine to highly specialized forms. When it comes to cam cutting machinery, however, while machinery builders have special tools for their own work, so far as the writer is aware, there is no tool regularly on the market for cutting

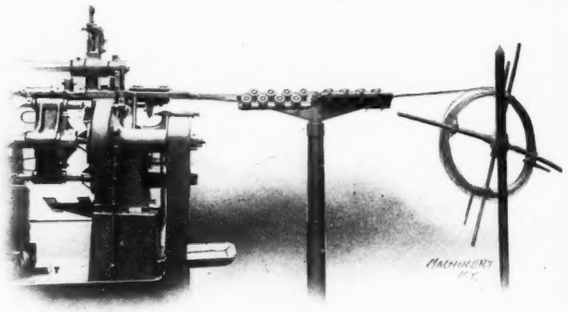

Fig. 8. Reel and Wire Straightening Rolls.

cams. The cam has thus fallen away behind the gear in the process of development. Machine designers and machine users are liable to be a little suspicious of cams, anyway. Considerable trouble is often taken to avoid the necessity for using them. This is due, however, as much to faulty design and faulty construction as to any inherent objections to this form of mechanical movement. The writer proposes to call attention to some of the points to be considered in designing and producing satisfactory cams, with the thought of thereby doing something to justify a more extensive use of them.

Faults in the Design of Cams.

We have all seen cams that were the cause of a good deal of profanity, in which the trouble could be traced to the designer or machinist, who laid out the curves on what might be termed "schedule time"; that is to say, he simply made sure of his starting and stopping points, neglecting all intermediate points so long as the movement got there and got back on time. This, he thought, would be all that was necessary, not taking into account the shock and jar caused by the sudden starting and stopping of heavy slides, levers, etc., at even moderate speeds. The temptation to do this is always strong,

*For additional information regarding cam design and cam cutting, see the following articles, previously published in MACHINERY: The Drafting of Cams, March and April, 1896; Cam Cutting, November, 1898; Making Master Cams, July, 1904; On the Shape of Rolls for Cylinder Cams, December, 1904; Cam Curves, April, 1907; Effect of Changing Location of Cam Roller, July, 1907.

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especially in the case of barrel cams, where it is so much easier to use the milling machine (gearing it up for a spiral to meet the schedule requirements) than it would be to lay out and form a curve with a gradual starting of the motion and a gradual stopping. There is nothing worse for the life of a machine than to have it operated by cams cut by this "schedule" method. Another point to consider is that of taking advantage of all the time there is for any given movement. The period or periods of rest should be cut down to the last degree, so as to have the angularity of the rise as small as possible. Careful work at the drawing-board will

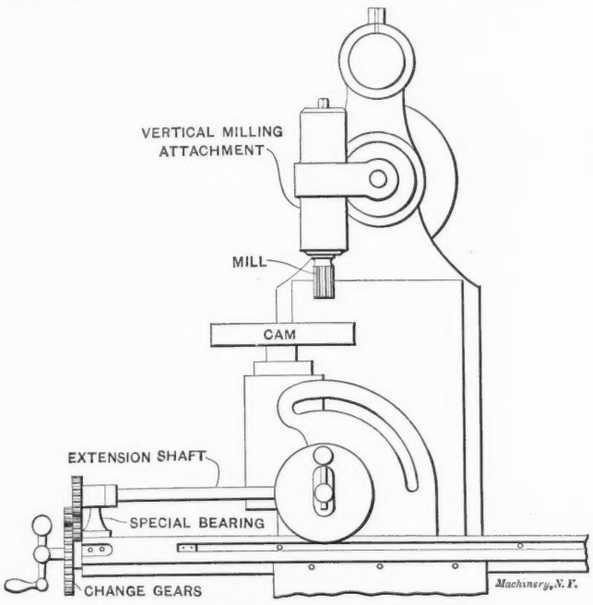


Fig. 1. Cutting a Face Cam of Uniform Rate of Throw.

make a big difference with the satisfactory action of cams in these two respects. Still another bad practice, which has perhaps tended to throw the use of cams into disfavor, is that of making them in two or more parts, with the idea of having the working surfaces adjustable. After they have been wedged out, or shimmed up, or ground off a few times, a more proper name for them would be "bumpers" rather than "cams." Except in rare cases, there is no more use or excuse for adjustable cams than for adjustable gears, as there are other and better means of making adjustments when these are necessary. Cams are not very expensive as compared with gears, and they can be duplicated with greater accuracy than most machine parts. Especially is this the case if roughing and finishing mills are used in forming them, as the finishing mill will retain its cutting edge and size for a great number of cams if it runs true with the spindle in the first place.

Cam Rolls and Roll Studs.

A few words might be said with relation to the design and construction of cam rolls and the studs for them, since the successful working of a cam depends to a considerable degree on this matter. The design of the roll and its stud should be such that the work it has to do, the speed at which it runs, and the bearing area on the stud, should be the factors determining its size, rather than the simple fact that there is a milling cutter in the tool-room of a certain diameter. It is equally important that the roll and stud should be ground all over after hardening. The end of the roll should also be cut back for 1/64th of an inch or so on the sides for some distance from the outside diameter, so as to avoid undue friction against the collar of the stud, or the part it is fast in. On account of the warping that takes place in hardening, rolls that are not ground inside and out have a habit of stopping frequently under load, until in time flat spots are worn on the face; then the working surface of the cam will begin to wear or rough up. Roll studs that are the slightest degree out of parallel to the working surface of the cam will also cause some trouble, but no amount of grinding will help this case. The same trouble occurs on barrel cams if the milling cutter is set above or below the center of the cam when cutting it. The roll will then bear at one end only at the most important time, when the throw takes place. A conical roll is the proper thing for this style of cam. There is a lot of end pressure to a roll of this type, however, which must be taken care of by thrust collars on the stud; or, better still, a ball race may be scored in the collar and the large end of the roll, so as to provide for a ball thrust bearing. This end pressure will reduce the side pressure on the stud to quite an extent, nevertheless, so the latter may be made slightly shorter or smaller in diameter than when a parallel roll is used.

Cutting Cams of Uniform Lead in the Miller.

When it comes to the cutting of cams, the shop man naturally turns to the milling machine. Many manufacturers of milling machines make attachments which may be used for cutting cams with formers. None that the writer has ever seen, however, is provided with anything except hand feed. Another, and the greatest, objection to them is that if there is much work to be done, one of the most expensive machines in the shop is tied up, and there are few shops that have a surplus of this brand of machine tool. For an occasional or an experimental job, however, there is nothing better than the milling machine. As has been before remarked, curves with easy starting and stopping movements cannot be cut without formers on it, or on any other machine for that matter; but cams which require a constant rise, such as the feed cams of some machines, may be cut on it without the use of formers. With barrel cams the method is obvious, it only being necessary to gear the spiral head with the lead screw to get the required lead, and then cut a groove of this pitch in the body with an end mill of the same diameter as the roll.

For cutting plate cams for the same kind of motion, the arrangement shown in Fig. 1 may be used, if the machine happens to have a vertical spindle milling attachment and a spiral head. All that it is necessary to provide in addition is the extension shaft shown, and the special bearing or bracket for supporting it. These parts are used to bring the spiral head to the center of the table. The shaft is bored out at one end to fit the stud of the spiral head (called the worm-gear stud in the tables) the other is turned and keyed to fit the change gears. The cams may be held in the regular chuck, or on a face-plate fitted to the head. Small ones may be held in an arbor fitted to the spindle, with large collars to hold them firmly, clamped with a nut and washer, or by an expansion bushing in the case of large holes. If they have key-ways in them and more than one or two are to be made, it will be well to fit a key in the arbor to help locate them. It is necessary to set the mill central with the spiral head

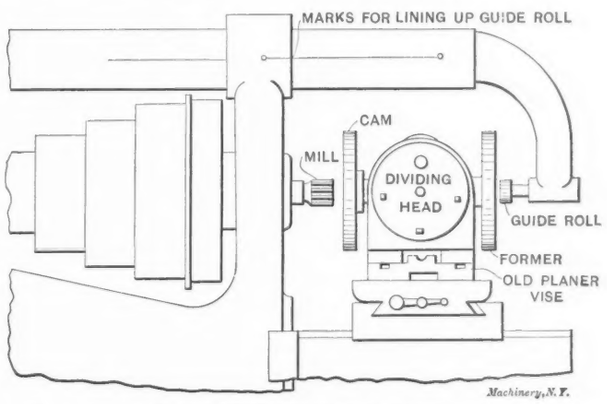


Fig. 2. Inexpensive Fixture for Milling Plate Cams to Match a Former.

to obtain correct results, as the spiral will vary if this is not done. Advantage may sometimes be taken of this when, with the regular change gears, there is no spiral of the exact pitch required, in which case the desired rise can be obtained by setting the head off center. This, however, will not give a uniform spiral, as the pitch will keep increasing as it leaves the center of the cam. As cam drawings are generally laid out or divided in degrees, it will be found convenient to divide the cam blank by the same method, while held in the spiral head. To do this, we may revolve the index crank through two holes in the 18 circle or three holes in the 27

circle, as many times as are necessary, each of these divisions giving exactly one degree.

A Milling Machine Attachment for Cutting Cams with a Former.

Not long ago I was working in a shop with a rather limited equipment, when an order came in for a lot of eight machines, which required seven cams each, most of which were of the plate type. As this class of work was new to the shop, we were without any facilities for this part of the job; as usual, it was decided to do the work on the milling machine. The methods used are shown in Figs. 2 and 3.

An old planer vise was scraped up and refitted so as to have the movable jaw a nice sliding fit—the screw having been removed, of course. To this jaw was fitted and bolted the spiral head of the miller, in such a way that its spindle could be placed either at right angles or parallel to the cutter, as the case required for barrel or plate cams. An arbor was made, long enough to pass through the head, carrying the former on the back end and the cam blank on the front end. A nut threaded onto the back end held the former against the end of the spindle, so there was no danger of the arbors rattling loose, no matter how badly the work and tool chattered.

For plate cams, as shown in Fig. 2, the former was made the opposite hand to that of the cam required. The overhanging arm had a center line marked on it as shown, which was matched with one on the frame so as to locate the arbor support central with the spindle. In the place of the arbor supporting center there was fitted a stud with a roller of the same diameter as the cutter. The arm was held securely by the regular milling machine braces, which are not shown in the cut. The method of operation is obvious. The spiral head with its attached work and former was revolved, slowly, by hand. The action of the roll, held by the overhanging arm in the groove of the former, causes the head and work to slide back and forth on the ways of the planer vise, giving the proper movement between the work and the cutter to produce the desired contour of cam. The table is locked on the saddle.

For barrel cams, the attachment was rearranged as shown in Fig. 3. The former roller was held firmly in a bracket bolted to the table of the machine. As the roller is on the

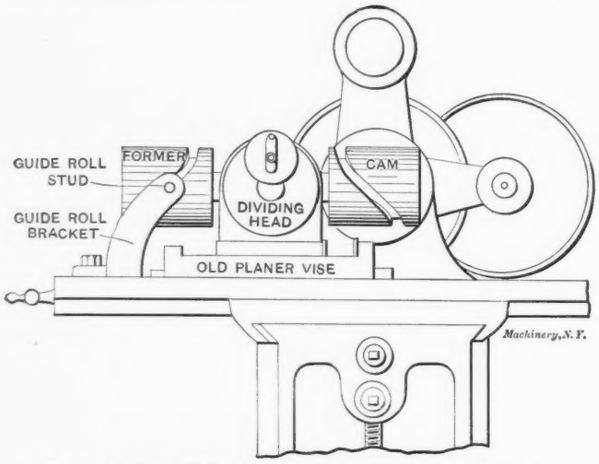


Fig. 3. Cutting a Cylindrical Cam with the Rig shown in Fig. 2.

opposite side of the milling cutter, the former and work are set 180 degrees apart on the work arbor, otherwise they are alike. The head is relocated on the movable vise jaw to bring the axis of its spindle at right angles to the axis of the cutter, as shown. The reader will be able to make out the other details from the cut.

Both of these rigs cut good cams, considering that the first cost of the whole outfit was very little. As the formers were made accurately to drawing, the cams gave good satisfaction at fairly high speeds, but the device had the disadvantage of tieing up a machine which had plenty of work waiting for it; besides it was a tedious job to feed the index crank by hand all day long, especially when working on steel cams. For these reasons, when a duplicate order came in, a few weeks later, it was considered best to try the plan of cutting the plate cams on an old lathe, thus giving us the advantage of an automatic feed, and relieving the miller of some of its work as well.

A Face Cam Cutting Attachment for the Lathe.

A lathe cam cutting attachment is shown in Fig. 4. While not new in principle, it differs somewhat from the other makeshifts described, and works better than most devices of the kind I have seen. The tool slide was removed from the machine and replaced with the bracket casting shown. This was fitted and gibbed to the tool-rest slide, and had its spindle bored and sides faced with a boring bar on the lathe centers. To the bracket was then fitted the cam face-plate and spindle, cast in one piece and finished all over, with the back or small

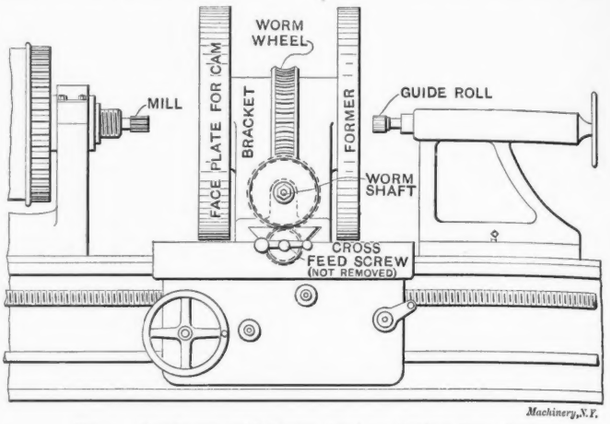


Fig. 4. Attachment with Power Feed for Cutting Face Cams.

end threaded to fit the former. Keyed to this spindle is a worm-gear of cast iron. In our case this worm gear had 82 teeth. Meshing with this gear is a worm having 9/16 inch hole, and a key and keyway, a sliding fit on the worm shaft. Bearings are provided for the worm shaft at front and back. The front support for the worm shaft was cast onto the bracket, and finished with it to fit the tool-rest slide, after which it was sawed off and fastened at the front of the carriage by the gib screw, as shown. This is the same practice as is commonly followed in making the clamp for the threading stop on the cross slide. To the outer end of the worm shaft is keyed a gear, meshing with another fitted and keyed to the front end of the cross feed screw next to the handle. The quill was cut off to make room for it. The cross feed nut was removed entirely, of course.

It will be seen that this arrangement, while having the general features of that shown in Fig. 2, gave us the advantage of making use of a less costly and less over-worked machine, and allowed us to use a power feed as well, since the gearing provided for connection with the power cross feed in the apron. This gave a feed fine enough for small cams, but on large ones it was necessary to run the feed belt from the feed shaft cone to the hub of the large intermediate gear of the screw cutting train, this being in mesh with the spindle gear. The lead screw was removed so as not to interfere with the belt. With regular changes this gave a wide range of feeds.

The cams and formers were held to their respective face-plates by bolts. All the formers were of the positive follower type having a groove for the roller to follow in. They require no weight or other means to hold them to their work.

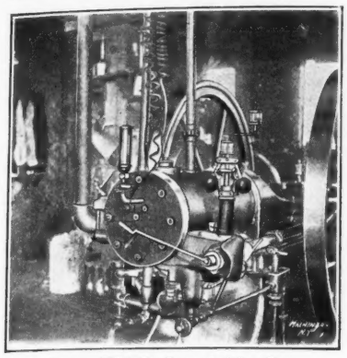
* * *

At the recent meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, E. W. Roberts performed some startling experiments with gasoline, lighting the vapor as it arose from an ordinary can and pouring gasoline into it as it burned, showing that it could not flash back into the can as that was full of gasoline vapor, forming rapidly enough to expel the air, and burning only after it issued into the atmosphere. The only danger of explosion is when a very small quantity of gasoline evaporates in a vessel, forming not enough vapor to expel the air, but sufficient to make with it an explosive mixture.—*Power.*

ITEMS OF MECHANICAL INTEREST.

STEAM WHISTLE OPERATED BY GAS.

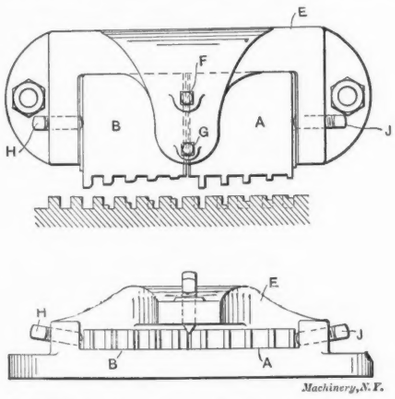
Not long ago I was in a small shop that got its power from a gas engine. It was just 12 o'clock, and I was surprised to hear two or three loud blasts from a steam whistle. I inquired if they kept a tank pumped with air at a high pressure, and was thereupon shown the following, which I managed to get a photograph of. As shown, a quarter-inch pipe leads from a hole in the cylinder head direct to a steam whistle with a small finger valve for operating. This makes me think how foolish so many gasoline yacht owners are, to go to the expense of hand whistles, etc., when with a "direct connected" they could get a blast of hot gas at between 200 and 300 pounds pressure. W. L. McL.



Steam Whistle Operated by Gas.

TOOL FOR CUTTING SQUARE SCREW THREADS.

In the cut below, taken from the *Mechanical Engineer*, is shown a tool of the chaser type for cutting square screw threads. This tool has been recently patented by Messrs. C. & G. B. Taylor, Bartholomew St., Birmingham. Ordinarily, square screw-thread tools, even when they have been used very little, are found to have worn to such an extent that the resulting groove is not as wide as required. It is obvious that it is impossible to regrind these tools after the sides of the cutting teeth have worn down below the required width. With the hope of overcoming this defect, the tool shown in the cut has been designed. As seen, the tool consists of two halves, *A* and *B*, each being provided with teeth which gradually cut the groove to the required depth. The required width is obtained by adjusting the relative position of the two tools *A* and *B*, so that the tool *B* widens the groove already cut by *A*. These two tools or chasers are held in a tool-holder *E*, and the adjustment is effected by means of two screws *F* and *G* having conical ends, which are forced in between the tools *A* and *B*, these in turn being clamped by the screws *H* and *J*. Whether the tool will prove to possess such practical qualities as will insure for it any extensive application is difficult to say, but the idea is ingenious, and may be applied in other cases than that of cutting square screw threads as well.



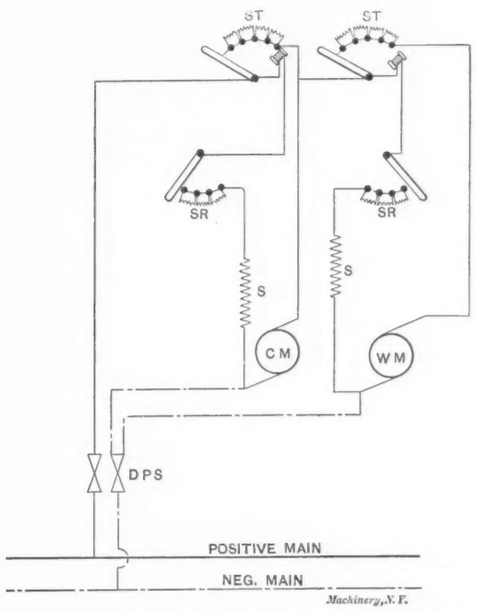
Adjustable Chasing Tool for Cutting Square Threads.

WIRING FOR MACHINES REQUIRING TWO MOTORS.

An electrically-driven thread miller, built by Drummond Bros., Ltd., of Gilford, England, is described in the European edition of the *American Machinist* of May 25, 1907. Two motors are used on this thread miller, one of them to rotate the cutter and the other to turn the work and feed it at the proper rate to give the spiral desired. This arrangement is obviously a good one, so far as doing away with the complicated mechanical connection is concerned. The cutter spindle can be easily swiveled to any angle desired without requiring the power which drives it to be transmitted through bevel gears, universal joints, and other devices of the kind.

There is one difficulty met with, however, in having no mechanical connection between the cutter spindle and the work spindle. If for any reason the cutter spindle stops from burning out of the motor, sticking of the cutter, or other mechanical or electrical reason, there is nothing to prevent the motor driving the work and feed mechanism from still going ahead to the damage of the work and cutter at least, and probably of the machine.

To make such a condition impossible the wiring connections shown in the cut are used. The work driving motor *W M* is wired through the last resistance contact of the left-hand starting switch belonging to the cutter driving motor *C M*. The release of the feed starting switch is tripped on the stoppage of the cutter motor, and, besides, it is impossible to start up the work motor until the starting switch of the cutter motor has been brought to the operative condition. If the cutter motor fails from over-loading, short circuiting or other defect, the automatic release of the starting box will throw back the starting switch and stop both mechanisms.



Wiring Arrangement for Machines requiring Two Motors.

This arrangement was the result of evolution. In the machine as originally designed, with a single motor drive, four changes in direction were necessary in the gearing, and although various forms of driving rod (including a square rod with four rollers, one on each side) were employed for transmitting motion, a considerable amount of power was wasted. Thus in this latter design each motor is of but ½ horse-power rated capacity, whereas in the earlier machines a two-horse-power motor was needed. For automatically stopping the machine at any point a tumbler switch is employed, this being simply clamped on the front of the machine in any position, cutting out both motors at the same time.

* * *

Rubber belting is ordinarily figured as averaging 1-16 inch thickness per ply. Thus a 7-ply rubber belt is about 7-16 inch thick, and corresponds in thickness to a heavy double leather belt. The permissible working load for average conditions may be taken as about 11 pounds per ply per inch of width, hence a 7-ply rubber belt 10 inches wide should safely carry $7 \times 11 \times 10 = 770$ pounds maximum working tension. The coefficient of friction should be figured about the same as leather, or say 0.3. Reuleaux limits it to 0.25. However, a still higher coefficient than 0.3 is frequently used for both leather and rubber belting in good condition and working under favorable circumstances.

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DESIGN—CONSTRUCTION—OPERATION.

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We solicit communications from practical men on subjects pertaining to machinery, for which the necessary illustrations will be made at our expense. All copy must reach us by the 5th of the month preceding publication.

AUGUST, 1907.

PAID CIRCULATION FOR JULY, 1907, 23,684 COPIES.

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition—$1.00 a year, comprising more than 430 reading pages. The Engineering Edition—$2.00 a year—contains all the matter in the Shop Edition and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

ON BEING LOYAL TO THE COMPANY.

There is a lot of tommy-rot said and printed about loyalty. Men in all kinds of service are entreated to be loyal to their employers, to further their interests in every possible way, to always speak well of them, etc. In being loyal to their employers they are told that they are loyal to themselves and to their own best interests. Very true, and we would be among the last to encourage any other spirit, but is it not true that men of every race and in any occupation, whether it be that of the soldier, sailor, artisan, or what not, are loyal only to that which commands their admiration and respect? We are loyal to our country, for we believe it to be the biggest, grandest, freest nation on earth, and so it is with a company. If a company is honest, progressive, fair and liberal in its treatment of employes and customers; in short, is an embodiment of what a manly man would be, it will have no need to cry for loyalty. On the other hand, if its policy is to gain every possible advantage, cut wages, discharge employes on specious pretexts, or because of failing health or advancing years after having served faithfully for long terms, to seize valuable inventions of employes without giving adequate return other than ordinary wages, to put sons of officers or directors in places of authority when they have not earned these places and are incapable of filling the positions without the help of unrecognized assistants, then we believe that loyalty is not to be expected, and men would be indeed poor creatures who would give heart service to such thankless masters.

* * *

THE ART OF CUTTING METALS.

In this issue (engineering edition) we give the concluding installment of our abstract of Mr. Taylor's presidential address made before the American Society of Mechanical Engineers last December. The length of this abstract is unprecedented in the history of MACHINERY, but then Mr. Taylor's paper was unprecedented in its scope and importance to machine tool builders and users, and we need make no apology for giving it so much space. Our regret is that it did not seem feasible to give the paper more nearly complete. As it was, it seemed best to give only that part which dealt with actual conclusions, leaving out the accounts of the methods of investigation, as every one specially interested would prefer the original paper in any case.

The concluding installment very properly ends with tables of practical cutting speeds for steel and iron (see data sheet) and illustrations of the slide rules used in the shop for the direction of machine operations. The slide rule embodying the twelve important laws, deduced as a result of the investigations, is a remarkable instrument. When individualized for each lathe in the shop, as is the practice in the Taylor system of shop management, it enables the speed and feed boss to set the speeds and feeds for any required job in a few moments so as to secure the *maximum* of efficiency and the greatest possible production of chips in a given time.

The expression "production of chips" may seem somewhat peculiar to many, but in this development the promoters of the system come to look upon turned shafts and other results of lathe work as by-products, the product with which they are most concerned as machine specialists being the removal of surplus metal. That this attitude is sound we think will be conceded by any one who comes to look upon the true function of machine tools in the proper light. In fact almost all machine and other tools are for the purpose of removing surplus materials so as to leave a certain shape or form. The more rapidly that material is removed the greater the production of chips, and incidentally the greater the production of the "by-product" which we ordinarily call *the* product.

* * *

FOREIGN MACHINE TOOL COMPETITION.

In another part of this issue are shown several engravings illustrating advanced machine tool building practice in a well-known British works. It will be observed that the methods of quantity production are practically identical with our own, the stringing of similar parts of lathes, planers, and other machine tools on the planer and milling machine platen being the same as that followed in all our leading machine tool-building shops. This practice, we believe, is only the logical development of the repetition system of manufacture in which parts are made on the interchangeable plan, because it is much cheaper and simpler to make them alike than to make each piece different, as is almost surely the result if each is machined separately, following ordinary methods.

The illustrations are instructive, aside from their purely mechanical interest, because they point out to American machine tool manufacturers that the day of active foreign competition has surely arrived, and that the foreign tool builders are prepared to meet them on their own ground so far as manufacturing methods are concerned. Of course this is no news to most of us, but here is the visual proof.

It is difficult to say just what part of advanced foreign practice is due to logical development and how much is mere imitation of American methods, but we believe it is fair to infer that almost any intelligent people engaged in manufacturing would eventually arrive at about the same methods followed by another people, even if they had not the example set before them. We had the advantage, in developing our manufacturing methods, of being in a new country where there was little precedent or practice established. Nearly everything was developed from the ground up. In fact our government is but little older than the Watt steam engine, the development of which is coincident with the present mechanical era. In Great Britain there were established industries much older than the steam engine, and notwithstanding the steam engine made cheap power available wherever fuel could be obtained, established practices and the hand-made-way of looking at things tended to retard the rate of development. The chief reason for the rapid development of labor-saving machinery in America has been the high cost and scarcity of labor. Where labor is very cheap, there is not the incentive to use labor-saving machinery, and that condition, of course, has existed very generally in Europe.

Some of our American tool builders have taken alarm at foreign competition and are advocating the closing of American shops to all visitors, and following a rigorous policy of secrecy in regard to all improved shop methods. We sincerely believe that there is nothing to be gained by such a policy and when that unlucky day arrives, if ever, the general effect will be to check machine tool design and construction wherever it is followed.

INTERCHANGE OF IDEAS A CAUSE OF PROGRESS.

In commenting upon the appearance of the new technical trade journal, *Werkstatts Technik*, the first one of any promise in Germany devoted exclusively to shop practice, the *Zeitschrift des Vereines Deutscher Ingenieure* finds occasion for a timely remark in regard to the causes which have made it possible for us in this country to distance Germany in the field of shop practice publications, although the latter country is one well known for its extensive use of printer's ink. It is pointed out that one of the most influential factors in the development of American industries has been the number of trade journals, and the free exchange of ideas and information which has taken place through these mediums. In Germany, on the other hand, it is stated that the shops have treated their methods as secrets and have been unwilling to give publicity to any of their experiences. The German writer in question freely admits that he thinks the superiority of American shop practice over that of German practice has been largely due to this fact, and points out how, as a rule, in America the shops are open to publicity, and that the principle is widely recognized that, without exchange of ideas, little progress is possible. This principle has also carried with it a willingness on the part of employers to either permit their employes to give publicity to their experiences in trade journals, or to permit representatives of trade journals to visit and gather information in the shops.

There is no doubt but that our German friend is perfectly right when he thinks that a great deal of the progress of American machine shop practice is due to free exchange of ideas, but on the other hand one must regret to observe that it appears as if American manufacturers in some cases at the present time were drifting into the German practice of considering a great deal of what is taking place in their shops as trade secrets. It may be argued that this attitude has been forced upon some concerns by the present-day competition, but it cannot be denied that concerns who stimulate the idea of keeping all their information to themselves, and considering their processes as trade secrets, while for the time being they may prosper by so doing, will in the long run be recognized as factors in retarding the progress of American industries. Inasmuch as there is no more certain way toward success for the whole nation in its endeavors to retain its supremacy, particularly in machine design and machine building, than a free, and we feel inclined to say, unlimited exchange of ideas, data and experiences, one must greatly regret to see a reaction in this respect. The Germans, having realized that publicity has been one of the strongholds of the excellent American shop practice, have of late greatly receded from their former attitude of secrecy, and it would be deplorable if, at the same time as the tendency there is toward the adoption of such practices as have, at least partially, caused our supremacy in this country in the past, we ourselves should enter upon the same road as they have found to be unprofitable, not only for the nation as a whole, but as an inevitable consequence, in the long run to each individual concern as well.

* * *

POSSIBLE INCREASE OF BOILER CAPACITY.

Experiments now being conducted by the boiler division of the United States Geological Survey fuel-testing plant at St. Louis, Mo., on the nature of boiler efficiencies have suggested that stationary boilers ought to be made to do *ten to twenty times* as much work per unit of heating surface as they do now. This great increase in capacity is to be attained by subdividing the heating surface and water streams more finely, by allowing less restriction of the water inside the boilers, and by using high forced and induced draft to put a large mass of gases through the boiler at a very high speed.

Up to the present time there have been only vague ideas among engineers as to what factors influence the efficiency of the steam boiler portion of the steam generator apparatus so as to cause it to absorb more or less of the heat generated by the combustion. Mr. John Perry, a distinguished mechanical and electrical engineer of England, went into the subject mathematically a few years ago and set forth general conclusions tentatively in his book "Steam Engine, and Gas and Oil Engines."

About a year ago, the government testing plant took up the mathematical investigation of the theory of the steam boiler and of heat absorption, and extended Mr. Perry's theory somewhat. For some weeks past, Mr. Walter T. Ray, assistant engineer, acting under the supervision of Prof. L. P. Breckenridge, engineer-in-charge of the boiler division, has been conducting a series of experiments on small multi-tubular boilers dimensioned so as to enable the theory to be verified, or modified, or refuted. The boilers are fed with air, heated electrically. Mr. Perry's theory states that modifying conditions being omitted from consideration, every boiler will always absorb, by convection from the gases passing through it, the same percentage of heat which could possibly be absorbed by any boiler containing water at a given steam temperature. This efficiency is, therefore, independent of the temperature of the entering gases and of the amount of gases flowing through the boiler.

As a practical example, assume that the water in a boiler circulates with entire freedom, which is an unwarranted assumption, and that its temperature is 300 degrees F.; let the gases enter the boiler at 1300 degrees F., then the difference between the two is 1000 degrees F., and consequently it would be possible for a boiler infinitely long to reduce the temperature of the gases passing through it to 300 degrees F. Let us assume, however, that the gases leave the boiler at 500 degrees F., which is 200 degrees above steam temperature. The efficiency of the boiler then is 80 per cent, because it has reduced the temperature 800 degrees out of a possible reduction of 1000 degrees.

If the same boiler be supplied with gases at 2300 degrees F., the gases enter the boiler at 2000 degrees F., above steam temperature. Mr. Perry's theory states that this particular boiler will reduce these gases in temperature 80 per cent as compared with a boiler infinitely long; that is to 400 degrees above steam temperature, which is 20 per cent of 2000 degrees, or to 700 degrees F. It will be noticed that the mass of gases does not enter into consideration at all.

This surprising deduction is being accurately verified by the Geological Survey fuel-testing plant, from which it is found, when keeping other conditions the same, and when keeping the initial temperature of the gases constant, that the final temperature of the air remains the same, whatever the amount of air sent through the boiler per second. So far the upper limit has not been reached with tubes clean inside and out, although the rate of evaporation has already been pushed up to many times that obtained even in locomotive practice.

Perry's theory takes into consideration four fundamental features affecting heat absorption at any point of the heating surface:

1. Temperature difference between the gases outside any portion of the boiler tube and the water inside.
2. The number of molecules per cubic inch in the gases outside the boiler tube.
3. The specific heat of the gases at constant pressure.
4. The velocity of the gases parallel to the heating surface.

Of the four above factors, only the first has usually been considered. It will be readily seen that if we increase the temperature of the gases, we decrease the number of molecules beating against any square inch of tube heating surface, and thus the second factor largely neutralizes the first.

The third factor can be taken as a constant equal to 0.24.

The fourth factor is the new and surprising one. Mr. Perry considers that a high velocity of gases parallel to the heating surface scrubs off more or less of the dense film of gases adhering to the metal surface, which film of gases has already become cold by proximity to the metal. The higher the velocity of gases, the more the scrubbing effect, and consequently the greater the amount of heat transmitted. This theory necessarily assumes that the ability of the metal to transmit heat is practically infinite, and when we consider that we ordinarily never put through a boiler tube more than 1/1000 of the heat it could carry, this assumption is warranted.

Mr. Perry's theory and the Survey's verification of it will result in placing the steam boiler on a fairly secure mathematical basis, the same as are now generators and motors. Thus far the experiments check out the theory excellently.

ENGINEERING REVIEW.

CURRENT MECHANICAL EVENTS—LEADING ARTICLES OF THE TECHNICAL PRESS.

The machinery of the new Cunard liner *Lusitania*, of which a general description was given in the August, 1906, issue of MACHINERY, is now all complete, and the vessel has left the shipbuilding yards for her trial trips on the river. The maiden voyage across the ocean is expected to be made early in the fall.

Consular reports indicate that the British government's trials with automatic stamp selling machines have proved successful. The machine tested is so perfect in its mechanism that it eliminates all bad coins, whether they be bent, counterfeit, or foreign. Another advantage of the invention is that no lever or handle has to be manipulated, the machinery being worked entirely by the weight of the coin.

During the month of June one of the greatest engineering projects of the times was commenced near Cold Spring, New York, west of the Hudson River. Enormous reservoirs are to be constructed in the Catskill mountains, and an aqueduct is to bring the water from there to the city of New York, a distance of about 100 miles. The work is estimated to cost at least $160,000,000, and will add 500,000,000 gallons daily to the present New York water supply.

A motor vehicle has been built in France, says the *Horseless Age*, which is suitable to run on both land and water. In other words, the vehicle is a motor boat mounted on wheels, the latter being of disk type and fitted with solid rubber tires. When entering the water, the motor is connected with a propeller. The hull is 13 feet long, and the maximum speeds obtained are 22 miles per hour on land and 6 miles per hour in water.

Experiments lately carried out in Vienna to introduce a system of regulating public clocks by means of wireless telegraphic impulses, have, it would seem by an announcement in the *Neue Freie Presse* of May 18, proved successful. A clock regulated on this principle was tested and was found to be wholly uninfluenced by stray currents, and kept perfect time in accordance with the regulating clock, 3.72 miles distant, which controlled its movements by wireless telegraphy.

Hot-water heating with mechanical circulation of the warm water is, according to the *Engineering Record*, being installed in connection with a gas engine plant in a small factory near New York. The factory will require about 400 H.P. in gas engines, and arrangements will be made to utilize all the heat in the jacket water and exhaust gas, practically 50 per cent of the heat furnished to the engine, for warming. Supplementary boilers will be installed for use at such times as these waste sources may furnish insufficient heat.

That the industrial future of a nation is largely dependent upon the placing of the control of its natural resources in the hands of the public, is becoming more and more recognized, and many nations have already commenced to act on this principle. The *Cologne Gazette* states that Switzerland has decided to place the control of the country's water-power in the confederate government, for the purpose of safeguarding the public's right in these natural resources as well as insuring the future industrial development of the country along equitable lines.

It is stated by the *Canadian Engineer* that there is a project on foot for the construction of a second canal at Suez, supported solely by British capital. The project, it is said, has taken definite form, and the British government is expected to grant a concession for the construction in the near future. The tolls charged by the French company controlling the present canal have long been claimed to be extortionate, and, as the British are the ones who use the canal most extensively, it is natural that they should try to get control of a canal of their own to further their shipping interests. It would seem, however, as if the plans to construct a new canal were largely of the nature of a gigantic bluff to bring the old company to terms.

The plans for the New York Connecting Railway Co.'s new bridge over Hell Gate, New York, have recently been approved. This bridge will connect the New York, New Haven & Hartford R. R. with the Pennsylvania system, the connection being made in Brooklyn. The bridge will form a part of a steel viaduct more than three miles long, the bridge itself being of arch construction, the main span being 1,000 feet between abutments. Eighty thousand tons of steel will be used in its construction. It will carry railroad tracks on stone ballast so as to render the structure noiseless.

One year's service with the steam turbine propelled Cunard liner, the *Carmania*, has shown results in excess of expectations. During the entire year the turbines have not been opened or needed any unusual attention. When the ship was first placed in service, the turbines were run only at a moderate speed as a precautionary measure, with a result that a rather low efficiency in operation was secured. On later voyages, the turbines have been speeded up, and it is interesting to note that the coal consumption is now almost identical with that which might be expected from the best quadruple expansion engine construction.

The use of vanadium is proposed in rail metal in order to prevent the frequent breakages. The use of vanadium in steel metallurgy is at present attracting much attention, and the great improvements in the mechanical qualities of steel, due to the introduction of this metal, are being recognized. Vanadium permits the even distribution of carbon, and retards constitutive segregation. The quantity of ferro-vanadium alloy required to produce the desired results is so small that the cost of the steel product is but little increased thereby, whereas the advantages resulting from its introduction could hardly be overestimated.

In the Engineering Review section of the July issue of MACHINERY mention was made of the need of imparting business education to engineers as well as technical knowledge, quoting an institute in Germany which makes a feature of giving instruction in bookkeeping, etc. In connection it was suggested that it would be highly commendable if higher technical institutions in this country would adopt the same idea. The note should properly have mentioned the notable exception of the Worcester Polytechnic Institute which makes a feature of giving its students some knowledge of practical commercial conditions of engineering. An article on shop management was contributed by Prof. Wm. W. Bird to the May issue of the *Worcester Polytechnic Institute Journal*, which is well worth perusal by those interested in this educational feature.

From Germany comes the news of a new composition to take the place of cedar as a material for the body of lead pencils. This material forms a pencil of compact composition, the main ingredient of which is potatoes. The invention is said to have been perfected, and the pencils are being manufactured in large quantities preparatory to being placed on the market. The United States Consul of Magdeburg, who sends in this information, says, that while these pencils are somewhat heavier than cedar, they are the same in size, form and appearance as those at present used, admit of sharpening a little more easily, and can be produced at a very low price. We have had occasion a number of times to note the ability of the Germans in making use of strange materials as substitutes for others better known and longer used. Perhaps, if there were any necessity for it, they might even be able to accomplish the proverbially difficult task of making a silk purse out of a sow's ear.

The increased use of large gas engines is shown by some figures given in the *Iron Age*, according to which there is at the present time 380 gas engines in use in Germany of 500 horse-power and larger, the average of each engine being 1,108 horse-power. The largest unit yet built is probably a 5,000 horse-power gas engine of Erhardt & Senmer, which has four cylinders 45 x 51 inches, and operates at 90 revolutions per minute. At present 29 firms in Germany build large gas engines, and of these 21 build double-acting four-cycle, 5 build two-cycle, and 3 firms build both systems of engines. Undoubtedly large gas engine units have so far been given greater attention in Germany than in the United States, but there is no question that their advantages are being recognized over here as well. One establishment alone in Germany has 35,000 horse-power of gas engines running, and there are two central power stations under construction which are to employ gas engines for generating electric energy for lighting and street car service. These stations will, when completed, have 50,000 horse-power of gas engines each.

It has been proved by Dr. Paul Heyl, of the Philadelphia Central High School, that visible and invisible light rays travel at the same rate. Dr. Heyl thereby won the Uriah A. Boyden prize of $1,000 deposited with the Franklin Institute in 1859. The offer of a prize has been published in each monthly issue of the *Journal of the Franklin Institute* for the past 48 years, and though a considerable number of essays have been read containing alleged proofs, none has proved satisfactory until the demonstration of Dr. Heyl. The method he employed was ingenious and simple, although the experiments required about two years' time and a great many tests. It was done by photographing the light of the star Algol, which is noted for its periodical variation in brightness. Photographs of the ultra-violet end of the spectrum were made through a refraction grating, this end of the spectrum being selected because the ultra-violet rays are invisible to the eye. Photographs were taken with 20-minute exposures at intervals of a half hour for six hours, which period is the time required for the fading and recovery of the light of this variable. It was found that the photographs changed in intensity according to the periods of intensity of the star as seen by the eye. In this way the coincidence of velocity of the visible and invisible rays is considered to be proved.

THE A. L. A. M. HORSE-POWER FORMULA.

At the last meeting of the mechanical branch of the Association of Licensed Automobile Manufacturers, which took place in Hartford, Conn., May 9, a horse-power formula was adopted which is to be used in the rating of automobile engines. In the formula adopted, D represents the cylinder diameter, and N, the number of cylinders. The formula adopted is

$$\text{Number of horse-power} = \frac{D^2 \times N}{2.5}$$

By means of this formula the following table, taken from the *Horseless Age*, has been calculated:

Bore of Cylinder, Inches.	Number of Cylinders.				
	1.	2.	3.	4.	6.
	Horse-power.				
3	3.6	7.2	10.8	14.4	21.6
3.25	4.2	8.4	12.7	16.9	25.3
3.50	4.9	9.8	14.7	19.6	29.4
3.75	5.6	11.2	16.9	22.5	33.7
4	6.4	12.8	19.2	25.6	38.4
4.25	7.2	14.4	21.7	28.9	43.3
4.50	8.1	16.2	24.3	32.4	48.6
4.75	9.0	18.0	27.1	36.1	54.1
5	10.0	20.0	30.0	40.0	60.0
5.25	11.0	22.0	33.1	44.1	66.1
5.50	12.1	24.2	36.3	48.4	72.6
5.75	13.2	26.4	39.7	52.9	79.3
6	14.4	28.8	43.2	57.6	86.4

It will be found that this formula, although it differs somewhat, is principally the same as the horse-power formulas by Mr. Dugald Clerk, which were published in the Engineering Review section of the January issue, this year.

EFFECT OF HIGH TEMPERATURES ON LUBRICATION.

W. K. Jervis, in the *American Machinist*, May 9, 1907.

Experiments were made for the purpose of determining the effect of higher temperatures than ordinarily occur, upon the friction set up in a given bearing by the oil film between the rubbing surfaces, pressure and speed being maintained constant. The oils experimented upon were common lard and machine oils, such as are used for cutting and lubricating purposes. The results obtained are doubly interesting because of the rather extreme conditions of pressure, speed and temperature under which the test was made, and because of the remarkable regularity with which the points, when plotted, fall on a smooth curve.

A Kingsbury oil testing machine was used, in which a vertical spindle ran between two opposed brasses in a bath

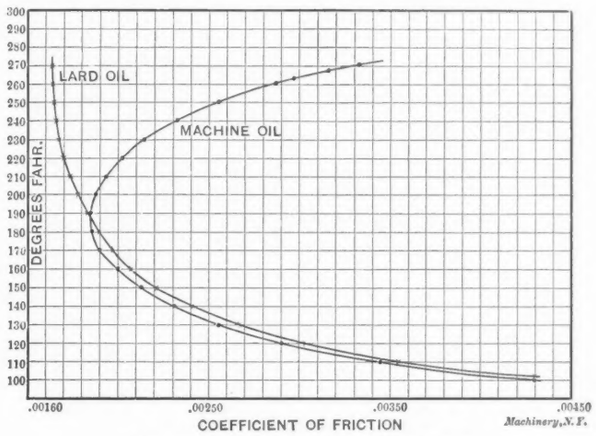


Diagram showing Result of Lubricant Tests.

of the oil under test, which was contained in a surrounding cylindrical case. The load on the bearing was applied by a heavy helical spring, passing through the side of the case and adjusted by a screw.

The oil case and its attachments were mounted upon a hollow vertical spindle, free to turn on the frame of the machine. The moment of friction of the journal tending to rotate the case was balanced by the torsion set up in a tempered steel wire by which the hollow spindle was supported, and the displacement of the case was read off in degrees from a circular arc on the frame of the machine. Heat was applied to the case and contents by means of a gas flame.

The results are shown in the accompanying curve. Up to about 180 degrees F. the coefficients of friction of both the lard and machine oils run very nearly together, the difference being about 3 per cent in favor of the machine oil. As the temperatures increase, producing a corresponding decrease in the viscosity of the oils, the curves show that the friction coefficients become less, reaching a minimum at 190 degrees for the machine oil, but continuing to decrease as much as 10 per cent more with the lard oil, the curve becoming nearly asymptotic to the temperature axis and showing no sign of change up as high as 280 degrees.

Evidently above 190 degrees the machine oil disintegrates, and the film between the bearing surfaces begins to break down; hence the friction increases very rapidly with the temperature.

A TWO-GAGE TRAMWAY TRUCK.

Tramway and Railway World, London, May 2, 1907.

The fact that different cities in England have adopted different gages for their street railway systems frequently makes it impossible for the two systems of neighboring towns to connect for the cars to be routed through. Such a condition exists at the two towns of Bradford and Leeds, the street railway systems of which connect. To make possible the running of a single car on the systems of both towns, C. J. Spencer and J. W. Dawson have designed a truck in which the gage is adjustable, enabling a single car to run on both sets of tracks. Two types of truck have been designed. On one of these the wheels and gears are mounted on sleeves which may slip along the axle. They are held in the extreme position by

means of locking blocks. As the car approaches the junction of the two tracks, the locking blocks are raised, and as it proceeds along a tapered section of the track, the wheels automatically change from one gage to the other. The blocks are then dropped, locking the wheels in the new position. In the other design the axle is divided at the center, and is itself adjustable axially. The running wheels and the gear are mounted rigidly on those two short axles, which are supported by means of boxes at the sides of the truck and by two additional boxes carried on brackets near the center. In both of these designs each motor is fitted with two pinions long enough to allow for the shifting of the gears. The change in gage is from 4 feet to 4 feet 8½ inches. A truck constructed according to the first design has been tried recently, and is said to have given satisfaction.

FORMULAS FOR GAS ENGINE FLY-WHEELS.

R. E. Mathot, in *The Engineering Magazine*, June, 1907.

The following formula for the calculation of fly-wheels for gas engines, is applied by Mr. R. E. Mathot to all classes of engines. If, in the formula,

P = the weight of the rim (without arms or hub) in tons;
D = diameter of the center of gravity of the rim in meters;
a = the amount of allowable variation;
n = the number of revolutions per minute;
N = the number of brake horse-power;
K = coefficient varying with the type of engine;

then, $$P = K\frac{N}{D^2an^3}.$$

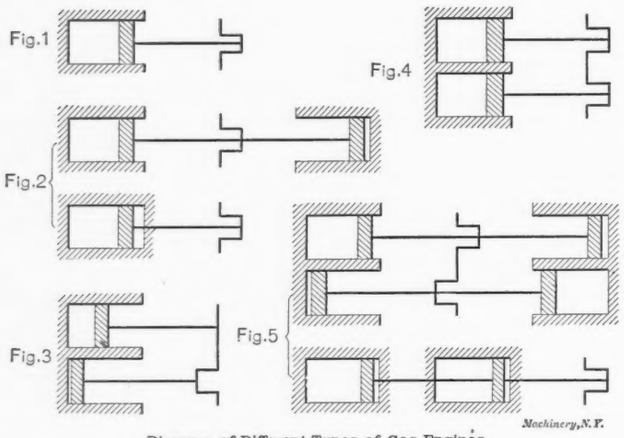


Diagram of Different Types of Gas Engines.

If D is transformed to feet, the formula will read:

$$P = K\frac{10.75\,N}{D^2an^3}.$$

The coefficient K, which varies with the type of engine, is determined as follows:

K = 44,000 for Otto-cycle engines, single-cylinder, single-acting. (Fig. 1.)
K = 28,000 for Otto-cycle engines, two opposite cylinders, single-acting, or one cylinder double-acting. (Fig. 2.)
K = 25,000 for two cylinders single-acting, with cranks set at 90 degrees. (Fig. 3.)
K = 21,000 for two cylinders, single-acting. (Fig. 4.)
K = 7,000 for four twin opposite cylinders, or for two tandem cylinders, double-acting. (Fig. 5.)

The factor a, the allowable amount of variation in a single revolution of the fly-wheel is as follows:

For ordinary industrial purposes..... 1/25 to 1/30
For electric lighting by continuous current.... 1/50 to 1/60
For spinning mills and similar machinery..... 1/120 to 1/130
For alternating current generators in parallel.. 1/150

The total weight of the fly-wheel may be considered as equal to $P \times 1.4$.

DIRECT LEAKAGE OF STEAM THROUGH SLIDE VALVES.

J. V. Stanford, in *Journal of the Franklin Institute.*

When the weight of steam used in an engine, as determined by condensing the exhaust, is compared with that computed from the indicator card, it is well known that there is considerable difference in the results. This difference between the actual and computed weights, commonly called "the missing quantity," and in some cases amounting to as much as 50 per cent of the steam used, is generally considered as being accounted for by condensation in the cylinder. The indicator card shows only the actual weight of vapor in the cylinder at a given time, taking no account of the steam which has entered the cylinder and has been condensed by transfer of heat to the cylinder walls. There is no doubt that a large part of the missing quantity may be charged up to cylinder condensation, but there is a possibility that some of it may be due to another cause, namely, valve leakage.

Experiments have been made at the Mechanical Laboratory of the University of Pennsylvania, to determine some facts in connection with leakage of slide valves. A set of tests was made on a 6-inch x 9-inch Sturtevant blower engine, driving a three-quarter housed centrifugal fan keyed direct to the shaft. The engine and fan had been installed in the boiler house of the university to create forced draft, and after a short period of use had stood idle with only an occasional run when used by the students for practice in valve setting. The engine has no governor, depending upon the throttle and the steady resistance of the fan to maintain the proper speed, and the valve is driven direct by the eccentric through a rocker arm. The valve is of the common D slide valve type, 5 inches wide by 4¾ inches long, overlapping the ends of the ports ¼-inch on either side. The engine had evidently been designed to work with the cut-off fixed at about 0.65 of the stroke, and during the tests the valve was set to give this cut-off. With this setting the minimum width of bridge covered by the valve was ⅝-inch, so that the exhaust port was everywhere protected from direct leakage by contact between the valve and seat at least ¼-inch in width.

A balance plate extends between the valve and chest cover to relieve the pressure between the valve and seat, and reduce the resulting friction. The balancing device consists of a cylindrical cup, bearing against a circular boss on the chest cover, and telescoping over a cylindrical projection from the top of the valve, the telescoping joint being made tight by two split rings. Contact is maintained between the balance plate and chest cover by four light springs. Steam leaking through the packing rings to the inside cavity of the balance plate is discharged through two 3/16-inch holes in the top of the valve direct to the exhaust cavity, so that the pressure over a large part of the valve is exhaust pressure. This leakage is also part of the missing quantity, for it goes to the condenser without affecting the indicator card.

In preparing for the tests, the engine exhaust was piped to a surface condenser, and arrangements made for collecting and weighing the condensation; a pressure gage was attached to the steam chest, and a revolution counter geared to the eccentric strap. Indicator cards were also taken. Two runs were then made with the engine working normally under the load of the fan, with the balance plate on the valve, and readings were taken to give weight of steam condensed, revolutions per minute, pressure in the steam chest, and the indicated horse-power. Average results from the two tests showed that the engine was developing about 5.13 horse-power, and was using about 91.2 pounds of steam per indicated horse-power per hour.

The balance plate was then removed from the valve, the holes through the top of the valve plugged with wood, leaving the valve unbalanced, and tests run as before. These tests gave a steam consumption of 60.5 pounds per indicated horse-power per hour, or 30.7 pounds less than when the balance plate was in place, due to the difference in leakage. In the first case the leakage was through the balance plate and under the valve; in the second case under the valve only, but the difference was probably due, not so much to leakage through the balance plate, as to the fact that in the first case the valve was only lightly seated, while with the balance plate removed it was seated firmly by the whole pressure of the steam, and a good joint maintained with the seat.

In order to determine the actual amount of leakage, the steam ports of the engine were plugged by driving in blocks of

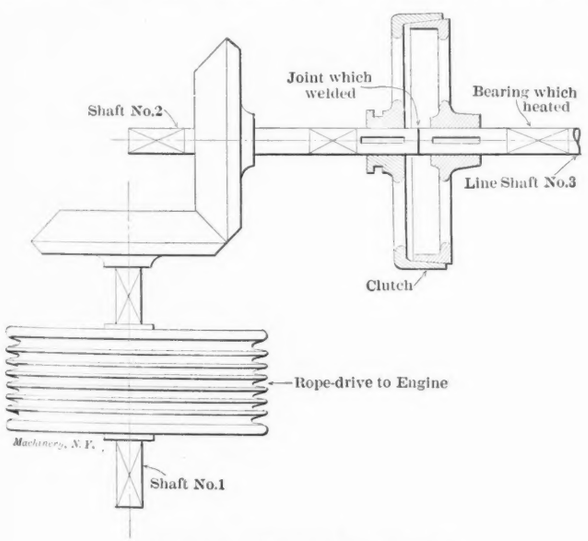
dry white pine, filling the steam passages flush with the valve seat. One cylinder head was then removed and the stuffing box opened to relieve any pressure in the cylinder due to leakage through the plugs. The eccentric sheave was loosened on the shaft and bolted to a large wood pulley placed beside it. The pulley was belted to a one-horse-power electric motor, geared to drive the pulley and eccentric about the shaft at the same speed as had been used in the previous tests. Having thus reproduced the conditions of the running of the valve as nearly as possible, except that all passages of steam to and from the cylinder were eliminated, it was fair to assume that all the steam now reaching the condenser was due to leakage from the chest to the exhaust, and that the amount was practically the same as when the engine was running normally. In running these tests, the motor was started and adjusted to the proper speed, then the throttle valve was opened carefully until the pressure in the chest was the same as in the other tests. A test under these conditions, with the balance plate on, showed the leakage amounting to 43.9 per cent of the total steam consumption.

As stated before, the engine had been standing idle for some time, and the valve and seat were not in perfect order, but their condition was not unusually bad, for when tested in the ordinary manner by opening the throttle with the valve standing still over the ports, only a trifling leakage was apparent, which makes it appear that the standing test for leakage, so commonly used, is a very poor index of what may take place when the valve is running.

In order to determine the effect of the balance plate in reducing the work required to drive the valve gear, the electric motor driving the eccentric was calibrated for efficiency and wattmeter readings taken, giving data for computing the power absorbed by the eccentric and valve under varying conditions. It was found that the power used with the balance plate on was 0.25 horse-power, and that it remained practically constant for varying pressures in the chest. Without the balance plate, the power required increased with the pressure and amounted to 0.38 horse-power for the pressure previously used. While the saving shown here is slight, the value of the balance plate for much larger valves is unquestioned, and no doubt results in a net saving when the parts are in perfect working condition, but it would seem that in a small engine receiving the ordinary care, its presence may become detrimental in the course of time, owing to its tendency to increase the leakage due to poor contact between the valve and seat.

A CURIOUS ACCIDENTAL WELDING OF STEEL SHAFTING.

A Russian correspondent of the *Scientific American*, in its issue of June 8, 1907, describes a peculiar accident which took



Accidentally Welded Joint in a Cotton Mill.

place in a large cotton mill near Moscow. From a steam engine of 1,500 horse-power, 350 horse-power is transmitted by a rope drive to one of the upper stories of the mill. The driven shaft makes 320 revolutions per minute. The motion is transmitted from the rope pulley to the line-shafting by a pair of bevel gears which, through a friction clutch, transmit the motion directly to the line-shaft of the mill. This arrangement is shown in the accompanying cut. By some mistake of the man who erected this rope drive, shafts Nos. 2 and 3 were put so closely together that they touched each other, and all the end pressure from the bevel gears was transmitted directly to the end of the line-shaft.

One morning, one of the bearings of the line-shaft became warm. The engineer, wishing to cool it, loosened the clutch and thus stopped it. Under these circumstances, all the pressure from the bevel gears rotating shaft No. 2 was applied to the end of the line-shaft. Both shafts were of the same diameter, about 6¾ inches. As this pressure was considerable, and the shaft was making 320 revolutions per minute, in a few moments the touching ends between the two halves of the clutch were heated not only to a red heat, but to the melting point as well, so that the liquid iron spurted to the walls. The engineer became very much frightened and signalled the engines to stop, and thus both the shafts became completely welded together. When they were cool, the engine was started again, but even with the friction clutch open, the full 350 horse-power was transmitted through this welded joint without breaking it. There was no further difficulty from hot bearings, owing to the fact that the shafts were welded in exact alignment. The shaft worked satisfactorily for over a month until there was opportunity to make the necessary repairs.

STEEL CASTINGS IN LOCOMOTIVE AND CAR CONSTRUCTION.

J. V. McAdam, in *Sibley Journal of Engineering.*

The increase of the use of steel castings in locomotive and car construction, as well as in machine building in general, is hardly realized by persons not directly in touch with the particular branches where these castings are used. The difficulty with steel castings is their liability to crack in cooling. For this reason brackets and ribs should be avoided wherever possible, as they tend to produce shrinkage cracks, on account of the extra thickness of metal and therefore slower rate of cooling where the rib joins the main casting. These cracks are often internal and do not appear on the surface. When the casting does not crack, it is liable to serious warping when cooling. Therefore it is often necessary to distort a pattern so that the finished casting will come out straight, as in the case of one which had a box-shaped end 6 inches deep and 13 inches wide. It was necessary to dish the top ⅜ inch in order that it might swell back straight in cooling.

Cast steel shrinks ¼ inch to the foot in cooling, being twice that of cast iron, and in a casting 20 feet long this amounts to 5 inches; it is therefore advisable to avoid, if possible, any large cross flanges or cores at the ends that will anchor the casting in the sand, and cause it to pull itself in two. The largest part of the shrinkage occurs at the point of recalescence when the matter is in a granular condition, neither liquid nor solid. In some cases thin ribs are cast on and chipped off when the casting has cooled. These thin ribs cool quickly, and are strong enough to hold the larger part of the casting together until it has set. If carefully designed, however, large castings can be made with perfect success. Large numbers of castings are now made which are 10 feet by 8 feet, and have no portion over ¾ inch thick. The greatest difficulty comes where thick and thin portions are wanted on the same casting, producing unequal cooling, which results in the first portion shrinking after the second has already set.

In designing steel castings, locomotive frames, and railroad cars, it is impossible to estimate the required strength with any degree of accuracy, for the reason that no one knows what the stresses are going to be with the moving loads. It is customary in freight car work to consider the dead load on a casting to consist of the weight of the car body, plus the rated capacity, plus 10 per cent overload. The casting is then designed with an ultimate factor of safety of from 6 to 8, which allows for the moving load. In some cases where the failure of the casting would be very serious, as in passenger car truck equalizers, the factor of safety is made even more.

The ultimate strength of cast steel varies from 70,000 pounds to 100,000 pounds, and the elastic limit is about half the ultimate strength with an elongation as high as 30 per cent. Tests would indicate that there is little difference, if any, between the value in tension and compression, but in all designing the tension side is made stronger than the compression in about the proportion of 6 to 5, for the reason that any defects in the castings are less serious in compression than in tension, and we can therefore afford to risk more.

Besides possessing high tensile strength, cast steel is tough and ductile, which makes it the ideal metal to resist shocks and carry heavy loads, and its general adoption in car and locomotive construction may be ascribed to its simplicity of design as compared with anything else, its lightness, and above all, its great strength.

PRINCIPLE OF THE BRENNAN MONO-RAIL CAR.

A. M. Worthington, in *Times Engineering Supplement*, June 5, 1907.

The Brennan mono-rail car includes an entirely new application of gyrostats in combination. The stability of the car depends, as the patent specifications show, on at least three distinct inventions: (1) The automatic calling into play of a force tending to accelerate precession, by the rubbing of the axle of spin as it rolls along a guide, an action which may be said to be borrowed from a spinning peg-top; (2) the regulation of the precession so as to leave the gyrostats, after any disturbance, always with their planes of spin parallel to the rail; (3) the combination of two linked gyrostats spinning in opposite directions, for meeting the exigencies of a curved track.

Foucault's Gyrostat.

To understand these points it is necessary to recall the behavior of Foucault's gyrostat. Let the diagram, Fig. 2, represent a heavy-rimmed disk with its spindle *O A* horizontal. This spindle turns in a ring or frame *B A C*, pivoted about the horizontal axis *B C*, at right angles to *O A*, on the frame

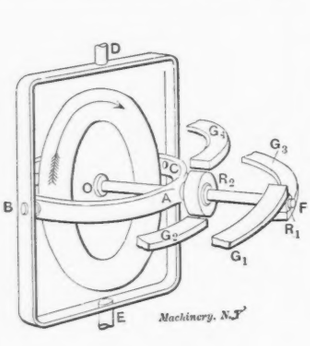


Fig. 1.

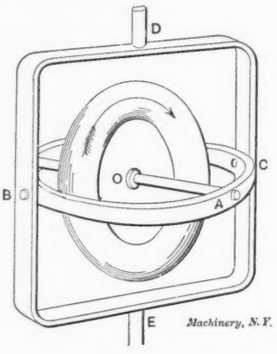


Fig. 2.

B D C E, which frame again is free to turn about the vertical axis *D E*. If the disk be not spinning, a downward pressure at *A* will cause *A* to descend with acceleration. If the disk be spinning slowly in the direction *B D C*, shown by the arrow, then *A* will not merely descend, but will move toward *B*, with rotation about *E D*, and a sudden removal of the pressure will leave the whole system violently oscillating.

If, however, the disk be spinning very fast, then we find that a downward pressure at *A*, maintained constant, produces no sensible depression of *A*, but creates what is called a precessional rotation of the spindle *O A*, at a constant rate about the axle *D E*, *A* moving toward *B* along the arc *C A B*, at a constant rate, so long as the rate of spin is unaltered. When the pressure ceases, there is only a slight and perhaps imperceptible tremor of the spindle *O A*, and we are left with the spindle displaced horizontally through an angle which is a measure of the time-integral of the couple that has been applied about the axis *B C* as it moved.

If, on the other hand, with the disk spinning very fast, the pressure maintained at *A* is not vertical but horizontal, in the direction of the precessional rotation just described, then there will be no apparent revolution about *E D*, but there will be a rotation of the frame *B A C* about *B C*, and *A* will rise, the angle through which *O A* rises being in this case a measure of the time-integral of the moment of the pressure about *E D*.

If now, while we maintain a constant downward pressure at *A*, we also apply a constant horizontal pressure as if to accelerate the horizontal precession of the spindle, then the precession will not indeed be permanently appreciably accelerated, but *A* will rise at a rate proportional to the horizontal force, and work will be done by the horizontal and against the vertical force.

Brennan's Application of Foucault's Gyrostat.

These are the chief relevant physical facts which lay at Mr. Brennan's disposal and of which he has availed himself with such remarkable skill and success. We will endeavor to explain his arrangement by pointing out its relation to the Foucault gyrostat just described. In the first place, the frame *E B D C* is pivoted on the body of the car at *E* and *D*, so that when the car is erect *D E* is vertical. Mr. Brennan then makes the spindle of his disk into the armature of an electromotor, whose field-magnets are carried by the pivoted and still balanced frame *B A C*. When everything is in equilibrium and the car is running erect, the spindle *O A* is horizontal and at right angles to the rail. We will suppose the car to be running in the direction *B C*, and will refer to *A* as the right-hand end of the spindle.

Now let a wind pressure be applied to the left side of the car. The car begins to turn over relatively to the gyrostat, and thus at once brings down a guide-plate G_1 (see Fig. 1) fixed to the car, and bent into a circular arc as shown, so as to press on a small roller, R_1, turning loosely about the end *F* of the spindle *O A F*, which now projects beyond the frame *B A C*. The pressure on this roller causes the spindle to precess from *A* toward *B* with an angular velocity proportional to the pressure, and the turning-over of the car is arrested, but at the same moment the friction between the rotating spindle and the roller makes the latter roll along the under side of the guide plate, and thus evokes a horizontal frictional force on the spindle, tending to accelerate precession. This causes the end *F* of the spindle to rise and push back the car against the wind pressure. Thus the car turns over to meet the wind, and is carried over beyond the vertical (perhaps considerably beyond) to a new inclined neutral position at which the moment due to gravity just balances the moment of the wind-pressure. This tilted position is reached, however, with a certain momentum which carries the car beyond it. Up to the instant of reaching this position the moment of the wind pressure has been in excess of the opposite moment of the gravitational pull, and the impulse that has acted is measured by the angular displacement of the spindle along the guide. From the instant that the car swings past the new neutral position, the moment of the gravitative pull-over to the left exceeds that of the wind pressure, and the car turning over to the left lifts the guide-plate G_1 off the roller R_1, and the gyrostat is left to itself, till a very slight further tilting over of the car brings a second curved guide-plate G_2 (fixed to the car) to bear on the lower side of a second roller, R_2, fitting loosely on a non-rotating sleeve which is part of the frame *B A C*. This arrests the further turning over of the car, and the gyrostat begins to precess back, but this time there is no force accelerating precession, so that the car remains tilted a little beyond the neutral position, till the roller, R_2, in passing beyond the middle position, is carried clear of the end of the guide-plate G_2; the gyrostat is now left again to itself, but the car being released from the pressure of R_2 at once falls over a very little more to the left, and thus brings to bear on the bottom of the rotating roller R_1 the third guide-plate G_3. The spindle now begins to roll over G_3; its precession is accelerated by friction, and the roller R_1 pushes back the guide-plate, and with it the car, up to and beyond the new neutral position of equilibrium, when the turning moment on the car again begins to be reversed, and the car, being now pushed over by the wind to the right of this position, brings its fourth guide-plate, G_4, to bear on the roller R_2, so that further turning is arrested, and the spindle *O F* precesses back to the middle position. In this way, the oscillations

about the new neutral tilted position quickly diminish, and by thus arranging that the car shall overshoot the mark and then return in oscillations of diminishing amplitude, the time-integral of the upsetting couple is reduced to zero, which is the condition that the spindle shall be left at rest in the middle, or "ready" position, after any adjustment. Each time the car has to move toward a new neutral position of equilibrium, work is done at the expense of the energy of spin of the disk; this, and the energy lost in frictional heat, is made up by the battery which maintains the rotation of the disk.

It is evident that, instead of an upsetting couple due to wind pressure, we may have one arising from a lateral shift of load on the car. The same process of self-adjustment will be gone through, the car inclining itself to the left if the shift of load is to the right; just as a man carrying a load on his right shoulder leans over the left till the center of gravity of his system is brought vertically over the supporting base formed by his feet.

Provision for Rounding Curves.

We have spoken, so far, of only a single gyrostat, but it is evident that if we endeavor to travel around a curve the spinning disk will maintain its plane of rotation unaltered in direction, and the car carrying the guides will sweep them round past the end of the spindle *F*, and thus the middle position will be lost. To remedy this Mr. Brennan employs a second similar gyrostat with an equal disk, spinning at an equal rate in the opposite direction, about a spindle which, when all is in equilibrium, is parallel to, or, in fact, in line with, the spindle of the first disk. The pivoted frame *B A C* of the first is so linked to the corresponding frame of the second that any lateral tilt of the first is communicated to the second, but at the same time each of the disks is free to precess. The precession of the second disk is equal to that of the first, but in the opposite direction, and any deviation from this equality and opposition is prevented by toothed gearing which connects the axle *E D* of the first with the corresponding parallel axle of the second. Such a system offers no resistance to turning with the car on account of a curve in the track, while to any upsetting moment it behaves like a single gyrostat of double mass, and enables the car to meet the upsetting moment of the so-called centrifugal forces by leaning over toward the inner side of the curve, exactly as it leaned over to meet a wind pressure.

It should, however, be observed that this adjustment does not get rid of the force tending to displace the rail laterally, and that this can only be completely met by sloping the track on which the rail is laid with exactly the same super-elevation as is required in an ordinary railroad curve (a slope which depends on the velocity prescribed). Mr. Brennan gets rid of the danger of upsetting, but not of the need of providing against displacement of the rail.

It remains to examine what will happen when we pass from a model to a car of larger dimensions. Fortunately the result works out very favorably, since we find that if we take the linear dimensions of everything *n* times greater, we can afford to spin the gyrostats *n* times slower, and yet secure the same righting effect, with the same angular movement and return of the spindle along the guides.

This result is of great importance, for it means also that the centrifugal stresses in the real gyrostats need not be greater than in the model, and that the rate of spin may be reduced from 7,000 per minute in the model to 875 per minute in a car of eight times the size. A greater rate in a smaller gyrostat is, however, a preferable option.

WINDMILLS.

R. M. Dyer, Seattle, Wash., in *The Iowa Engineer*.

A short historical review of the windmill used as a prime mover will be necessary to establish a basis upon which some of our later facts may be founded. Whether or not windmills were used prior to the tenth century is not clearly established. The type of wheel which we know as the "Dutch wheel" evidently developed about that time, and for 700 years held its own with but few variations. The "Dutch wheel," so called because used in such great numbers in Holland, consisted of a main shaft, supporting four radiating arms, carrying light framework to support the canvas or other sail material; the main shaft communicated the power when produced to the machinery, which usually consisted of a paddle wheel water pump, a millstone, or a stamp mill. These mills were turned up to the wind by hand power, sometimes the whole mill turned on a pivot, sometimes the upper half only, and later only the top of the mill, which carried the main shaft and windmill.

Earliest Improvements on Ancient Windmills.

The earliest effort to improve the operation of these mills is recorded in 1780, when a device for reefing the sails while in motion was made by Andrew Miekle. This device, as well as that of Sir William Cubett (1807), designed for the same purpose, was accomplished by the effect of centrifugal governors. To the last-named inventor belongs the credit of first using an auxiliary windmill set at right angles to the plane of the main wheel to keep the windmill headed up to the wind without the constant attention of the attendant.

A few windmills of the Dutch type were built in America. Two of them stand within a few hours' trolley ride from Chicago, but for the purposes for which such power could be best used, that of pumping water, a design of mill gradually developed in America, known as the "American windmill," being a small wheel 12 to 20 feet in diameter, almost filled with wooden slats. This style of mill held its own for many years in its crude form.

The Halliday Windmill.

Daniel Halliday made the windmill a safe and practical machine by inventing and perfecting a wheel, the sails of which were connected up in groups or sections, which pivoted under control of centrifugal governor balls, and thereby held the mill to a reasonably safe speed at all wind velocities. The Halliday interests were afterward taken over by the existing company, the United States Wind Engine and Pump Co., of Batavia, Ill. The Halliday method of governing had and has many imitators, but none seems to have equaled the original. Another favorite method of governing used by the early builder of windmills was the "solid wheel with side vane," a small vane being attached rigidly to the frame which carried the head of the wheel, which would turn the wheel edgewise or partly edgewise to the wind when acted upon by winds above normal velocities. Variations of these two methods of governing formed the basis of innumerable patents between 1860 and 1890, during which time the manufacture of wooden windmills flourished and the number of manufacturers increased to a score or more. The Leffel wheel, made at Springfield, Ohio, between 1880 and 1885, showed the first departure from seemingly fixed methods of regulation in having the wheel set off from the center line of the vane, thereby avoiding the use of the small side vane, the force of the wind acting directly on the face of the wheel to bring it out of sail as the wind velocity increased above normal. The wheel was made with a sheet iron wheel and with a wooden vane.

The Modern Windmill and its Development.

The actual development of the windmill wheel as we know it was due primarily to the work of Mr. Thomas O. Perry. Mr. Perry was and is a gentleman of scientific and mathematical attainments and had interested himself for some years previous to 1882 in the development of the windmill and other machinery used in agricultural pursuits. At this time a preliminary study of Smeaton's and Weisbach's theories convinced him that the data upon which their deductions had been made lacked thoroughness and completeness; that the assumptions upon which these formulas had been based were, in part, erroneous, and that the wheels which had been used to develop the empirical elements of their equations were poorly suited to produce satisfactory results. He, therefore, developed by strictly theoretical and mathematical means, a new set of formulas, and made several startling suggestions in reference to improvements in windmill design. It might be mentioned that instead of using the elements of pressure and velocity of the wind as the basis of his power formula he used the more rational factor "kinetic energy" of the air current intercepted by the wheel.

In 1883 a laboratory was fitted up by the Halliday Company in Batavia, Mr. Perry being placed in charge, to test out on an elaborate scale his theory in reference to the design of windmills, as well as also to test the forms of wheel that several others had suggested. The following points, which were fully covered by these tests and experiments were established by several thousand tests on many forms of wheels: Form of sail, necessity of a thin sail, angle of sail or "weather;" effect of various obstructions before and behind the wheel; effect of obstructions within the wheel, such as wheel arms, connecting members of the wheel, etc.; proper amount of sail surface, speed of wheel, relative to velocity of wind, and, in fact, every question which had arisen at that time bearing on the design of wind wheels.

Result of Perry's Experiments.

Experiments developed that the old flat wood sail was not as efficient as the curved steel sail; the angle of weather was chosen most favorable for a light wind, 4½ to 5 miles per hour being utilized with some efficiency. Any windmill will run in a high wind, but a well designed mill must work in a light wind. A mill that requires a ten-mile wind may run only four or five hours per day; a mill that will run in a five-mile wind will probably run eighteen hours per day in some localities. Experiments developed the fact that seven-eighths of the zone of interruption could be covered with sails; that more than this was detrimental, and that the gain in power in from three-fourths to seven-eighths of the surface was so small that the use of the additional material was not justifiable; that the sail surface should extend only two-thirds the distance from the outer diameter to the center; that a wheel running behind the carrying mast is not nearly as efficient as one running in front of the mast; that there should be the least possible obstruction behind the wheel; that to be efficient the velocity of the travel of the vertical circumference of the wheel should be from 1 to 1¼ times the velocity of the wind, hence the necessity of back gearing to reduce the pump speed to forty strokes per minute as a maximum, which is the limit of safety at which ordinary pumps can be operated.

Perry records that with his experimental wheel he actually developed 44 per cent of the kinetic energy of the impinging air current; however, if an efficiency of over 35 per cent is sought for, a comprehensive study of the physical elements entering into the absorption of the kinetic energy of an intercepted air current by a wind motor operating under the most favorable conditions of wind velocity, curvature of sail, amount of sail surface and travel of sail, will show that the high rate of sail travel becomes prohibitive if such wheels are to be considered in view of their cost and maintenance, either as a manufacturing possibility or as an economic motor.

Power of Windmills.

Theoretical demonstrations show that the intercepted area of air current varies as the square of the diameter of the wind wheel, and that the kinetic energy of the air, impinging on such an intercepted area, varies as the cube of the wind velocity; consequently, we might say that the power of windmills of the same type varies as the square of the diameter, and as the cube of the wind velocity. This is true within reasonable limits, but as the wheel is designed to give its best efficiency in low winds, say 10 to 15 miles per hour, we cannot expect that the same angle of sail would obtain the same percentage of efficiency in winds of considerably higher velocity.

The ordinary wheel works most efficiently under wind velocities of from 10 to 12 miles per hour. Such wheels will give reasonable efficiency in from five to six-mile winds, while if the wind blows more than 12 miles per hour, we will have power to spare. Our wheel must work in light winds, such being nearly always present, while the higher velocities only occur at intervals. Mills built for grinding purposes, geared mills, or power mills as they are called, when attached to a grinder, having a centrifugal feed, will develop power almost approaching to the cube of the wind velocity, within reasonable limits of such velocity, as their speed need not be kept down to a certain number of revolutions per minute, as in the case of the pumping mill.

Should this theoretical condition hold, the following table, showing the amount of power for different sizes of mills at different wind velocities, would apply. Figures show H.P.

Size.	5 miles.	10 miles.	15 miles.	20 miles.	25 miles.	30 miles.	35 miles.	40 miles
8 feet....	.011	.088	.297	.704	1.375	2.176		
12 feet....	.025	.20	.675	1.6	3.125	5.4	8.57	12.8
16 feet....	.045	.36	1.215	2.88	5.52	9.75	15.3	21.04

These figures have been proved by laboratory tests at velocities ranging from ten to twenty-five miles per hour, and more, by the Murphy tests on mills actually in use, which show very close relation at the wind velocities at which the mills are best adapted.

The Murphy figures are as follows:

Size of Mill.	10 miles.	15 miles.	20 miles.
12 feet	0.21 H.P.	0.58 H.P.	1.05 H.P.
16 feet	0.29	0.82	1.55

For higher wind velocities the Murphy values fall much under the theoretical values, but the range of velocities over which his experiments extend does not justify any change in the general law except inasmuch as common sense teaches us that theoretical conditions can rarely be attained in actual practice.

In view of the fact that a windmill does not work as efficiently in high winds as in winds under 20 miles per hour, my experience would lead me to believe that the following figures (H.P.) would be the probable extension of the Murphy tests:

Size of Mill.	25 miles.	30 miles	35 miles.	40 miles.
12 feet.	2.5	4	5	6
16 feet	4	6	8	10

A 20-foot mill would deliver approximately 50 per cent greater power than a 16-foot.

Modification in Speed and Size Required by Practical Conditions.

The foregoing tables must be translated with reasonable allowance for conditions under which wind wheels must work, and which cannot well be avoided, *e. g.*, pumping mills must be made to regulate off at a certain maximum speed to prevent damage to the attached pumping devices. The regulating point is usually between 20 and 25 mile wind velocities, so that no matter how much higher the wind velocity may be, the power absorbed and delivered by the wheel will be no greater than that indicated at the regulating point. Again, owing to the peculiar construction of geared windmills, the torque of the vertical shaft operates to prevent the mill from regulating off; consequently, when working, the mill is held up squarely to the wind, until the load imposed by the attached devices ceases to absorb all of the power which the mill will deliver. After this condition obtains, any increase in wind velocities causes the mill to regulate or turn out of the wind. The regulation point on such mills when loaded is, therefore, usually placed at wind velocities of from 30 to 35 miles.

Another subject which needs some consideration is the fact that while the power of a mill increases approximately as the square of its diameter, the weight of the machine increases approximately as the cube of its diameter.

It is useless to waste time in a discussion of the comparative merits of wooden and steel windmills, while giving due credit to the excellent workmanship and the extreme care in the selection of the material used on some of the old wood wheels which have stood so long in some localities as to have become historical landmarks. The wood wheel, as generally constructed, is an inefficient, short-lived affair, designed without reference to the principles of wind dynamics. Actual tests have shown that some wood wheels, under certain wind conditions, will give more power with every alternate slat removed, and on wood wheels having slats ½ inch thick and 3 inches wide, the efficiency of the wheel is reduced nearly one-sixth, merely from the action of the wind on the edge of the slat.

* * *

It is said to be extremely important to the proper setting of concrete, if the best results are to be obtained, that it be protected, while the process is going on, from the wind and sun, especially in dry, warm weather. The dry air will rob the sharp corners, and even the faces, of their moisture, and a later wetting is no remedy.—*Scientific American.*

IRON AND STEEL.*

Commercial iron and steel are metallic mixtures, the chief ingredient of which is the element "iron," that is, pure iron, of which they contain from 93 per cent to over 99 per cent. The difference between iron and steel is principally due to the composition and proportion of the remaining ingredients.

Iron ore is an oxide of iron (iron rust) containing from 35 per cent to 65 per cent of iron; the balance is oxygen, phosphorus, sulphur, silica (sand), and other impurities. The ore is charged in a blast furnace, mixed with limestone as a flux, and melted down with either charcoal, coke, or anthracite coal as fuel; the resulting metal is what is commercially known as pig iron, containing about 93 per cent of pure iron, 3 to 5 per cent of carbon (pure coal), some silicon, phosphorus, sulphur, etc. This pig iron is used in foundries for the manufacture of iron castings, by simply remelting it in a cupola without materially changing its chemical composition; the only result is a closer grain and somewhat increased strength.

The Puddling Process.

In the manufacture of wrought iron the pig iron is remelted in so-called puddling furnaces, by charging about ½ ton in a furnace, and, while in a molten state, it is stirred up with large iron hooks by the puddler and his helper, and kept boiling, so as to expose every part of the iron bath to the action of the flame in order to burn out the carbon. The other impurities will separate from the iron, forming the puddle cinder.

The purer the iron the higher is its melting point. Pig iron melts at about 2,100 degrees F., steel at about 2,500 degrees, and wrought iron at about 2,800 degrees. The temperature in the puddling furnace is high enough to melt pig iron, but not high enough to keep wrought iron in a liquid state; therefore, as soon as the small particles of iron become purified they partly congeal (come to nature), forming a spongy mass in which small globules of iron are in a semi-plastic state, feebly cohering with fluid cinder filling the cavities between them. This sponge is divided by the puddler into lumps of about 200 pounds each; these lumps or balls are taken to a steam hammer or squeezer, where they are hammered or squeezed into elongated blocks (blooms), and while still hot, rolled out between the puddle rolls into bars 3 to 6 inches wide, about ¾ inch thick, 15 to 30 feet long. These bars are called puddle bars or muck bars, and, owing to the large amount of cinder still contained therein, they have rather rough surfaces. The muck bars are cut up into pieces from 2 to 4 feet long, and piled on top of each other in so-called "piles" varying from 100 to 2,000 pounds according to the size product desired. These piles are heated in heating furnaces, and when white hot, are taken to the rolls to be welded together and rolled out into merchant iron in the shape of either sheets, plates, bars, or structural shapes, as desired. When cold, this material is sheared and straightened, and is then ready for the market.

After leaving the puddling furnace, wrought iron does not undergo any material change in its chemical composition, and the only physical change is an expulsion of a large portion of the cinder; the small cinder-coated globules of iron are welded together and the subsequent rolling back and forth will elongate these globules, giving the iron a fibrous structure, and the reheating and rerolling will drive these fibers closer together, thus increasing the strength and ductility of the metal.

Classes and Kinds of Steel.

The word steel, nowadays, covers a multitude of mixtures which are very different from each other in their chemical as well as physical qualities. The ingredient that exerts most influence on these variations is carbon. High grade razor steel contains about 1¼ per cent of carbon, springs 1 per cent, steel rails from ½ to ¾ per cent, and soft steel boiler plate may go as low as 1/16 per cent of carbon. Steel which is very low in carbon can easily be welded, but it cannot be tempered; when carbon is above 1/3 per cent, welding is more difficult and can only be done by the use of borax or some other flux, or by electric or thermit welding. Steel with carbon above ¾ per cent can be tempered, that is, when heated to red heat and then quenched in water or other liquid, it becomes very hard and can be used for tools of various kinds, such as saws, files, drills, chisels, cutlery, etc. In tool steel other ingredients are sometimes used to influence its hardness, such as nickel, manganese, chrome, tungsten, etc., the last named playing an important part in so-called "high speed steels," that is, steel tools that will cut metal at a high speed without losing their temper or hardness.

As stated above, pig iron and cast iron contain about 4 per cent of carbon, and wrought iron only a trace of it, while steel is between these two extremes. The manufacture of steel, therefore, refers principally to getting the right proportion of carbon. One method is to take pig iron and burn the carbon out of it, as in the Bessemer and open-hearth processes, and the other method is to take wrought iron and add carbon to it, as in the cementation and crucible processes.

The Bessemer Process.

In the Bessemer process the molten pig iron is put into a large pear-shaped vessel, called the converter, the bottom of which is double, the inner one being perforated with numerous holes, called tuyeres, to admit air to be forced in under pressure. The molten iron (from 10 to 15 tons at a time) is poured into the converter while the latter is lying on its side, then the compressed air is turned into the double bottom as the converter rises to a vertical position. The air has sufficient pressure (about 20 pounds per square inch) to prevent the molten metal from entering the tuyeres. The air streams pass up through the molten metal (piercing it like so many needles), burning out the carbon, silicon, etc., accompanied by a brilliant display of sparks and a flame shooting out of the mouth of the converter. The 15 tons of molten pig iron contain nearly ¾ of a ton of carbon, and since this carbon is all burned out in less than ten minutes, this rapid rate of combustion increases the heat of the metal very much; it does not cool it, as one would suppose at first thought. The flame, therefore, at first red, becomes brighter and brighter, until it is finally so white that it can scarcely be looked at with the naked eye. A "blow" generally lasts about nine to ten minutes, when the sudden dropping of the flame gives notice that the carbon is all burned out. The metal in the converter is then practically liquid wrought iron, the converter is then laid on its side again, the blast shut off and a certain amount of spiegeleisen or ferromanganese is added in a liquid form so as to give the steel the proper amount of carbon and manganese to make it suitable for the purpose desired. The liquid steel is then poured out into so-called "ingot molds," and the resulting "ingots," while still hot, but no longer liquid, are rolled out into blooms, billets, or rails without any additional reheating except a short sojourn in so-called "soaking pits." In some steel works, where the molten pig iron is taken in large ladle cars direct from the blast furnace to the converter, it is possible to produce rails without adding any fuel to that contained in the molten pig iron, so that the red-hot rail just finished still contains some of the heat given it by the coke in the blast furnace.

The Open-hearth Process.

The open-hearth process, sometimes called "the Siemens-Martin process," is similar to the puddling process, but on a much larger scale. The furnaces generally have a capacity of from 40 to 50 tons of molten metal (in some exceptional cases as high as 200 tons); they are heated by gas made from bituminous coal (oil and natural gas have also been used). The gas and the air needed for its combustion are heated to a high temperature (over 1,000 degrees) before entering the combustion chamber, by passing them through so-called regenerative chambers. Owing to this preheating of the gas and the air, a very high temperature can be maintained in the furnace, so as to keep the iron liquid even after it has parted with its carbon. The stirring up of the molten metal is not done by hooks as in the puddling furnace, but by adding to the charge a certain proportion of ore, iron scale, or other oxides, the chemical reaction of which

* Article by George Schuhmann, General Manager Reading Iron Company, published in *The Pilot*, official organ of the Philadelphia and Reading Railway Department Y. M. C. A., Reading, Pa.

keeps the molten iron in a state of agitation. While in the Bessemer process only pig iron is used, in the open-hearth furnace it is practicable to use also scrap of wrought iron or steel, as the high temperature in the furnace will readily melt it. When the pig iron or scrap contains too much phosphorus, burnt lime is added to the charge; the resulting slag will absorb the phosphorus, thus taking it out of the metal. This dephosphorization by means of burnt lime is called the basic process in contradistinction to the acid process, where no lime is used, but where care must be taken that the metal charged is low in phosphorus. In this country, the basic process is at present used only in connection with open-hearth furnaces, while in Europe it is also used in many Bessemer plants producing the so-called "basic Bessemer steel."

Producing Tool Steel.

Crucible steel or tool steel, formerly called cast steel, is made by using high grade, low phosphorus wrought iron and adding carbon to it. The oldest method is the so-called "cementation process" in which the iron bars are packed in air-tight retorts, with powdered charcoal between the bars. The filled retorts are put into a cementation furnace, where they are heated to a red heat and kept at that temperature for several days, during which time the iron will absorb about 1½ per cent of its own weight of carbon. The process is similar to the case-hardening process familiar to many blacksmiths. The carbonized bars, called "blister steel," are then cut into small pieces, remelted in a crucible, and from there poured into molds, forming small billets, which are afterward hammered or rolled into the desired shapes. The newer method is to put the small pieces of wrought iron direct into an air-tight crucible mixed with the proper amount of powdered charcoal, and melt down; the iron will absorb the carbon much quicker while in a molten state than when only red-hot, as in the cementation furnace. The other ingredients, such as chrome, tungsten, etc., are also added in the crucible.

Malleable and Steel Castings.

Malleable castings are produced in the reverse way from the blister steel referred to above, that is, instead of taking wrought iron and adding carbon, castings made of cast iron are made malleable by extracting the carbon. The castings are packed into retorts similar to the cementation retorts, but, instead of charcoal, an oxide of iron, generally in the shape of hematite ore, is packed with them, and kept in a red-hot state for several days. The oxygen of the ore will absorb the carbon in the iron, giving the latter a somewhat steely nature.

Steel castings used to be produced in the same manner, but now, steel castings are cast direct from the ladle containing molten steel, which is generally melted in an open-hearth furnace, although small Bessemer converters are also sometimes used for this purpose.

Comparison between Wrought Iron and Low Carbon Steel.

While chemically there is not much difference between wrought iron and low carbon steel, there is considerable difference in their physical structures. Owing to the globules of pure iron being coated with cinder in the puddling furnace, the subsequent rolling and reworking while expelling a large portion of this cinder always leaves traces of it behind which gives wrought iron the fiber. Steel having been produced in a liquid form, where the cinder all floated to the top and was removed, the metal is homogeneous, that is, without any grain or fiber. When subjected to many vibrations, or strains due to frequent expansion and contraction, wrought iron will generally yield gradually and give warning to the inspector, while steel is more liable to snap off suddenly. Wrought iron being composed of many fibers, the fibers can break one at a time without directly affecting its neighbor (like the strings in a rope), while a rupture once started in steel will extend more rapidly. Wrought iron will also resist corrosion and pitting longer than steel, no doubt due to higher resisting power of the enclosed cinder, which also causes the acid to deflect endwise, thus weakening its action by diffusing it over a larger area and preventing deep pitting. Stay bolts and boiler tubes for locomotives have proved more satisfactory when made of charcoal iron than of steel. Thin sheets, tin plate, corrugated iron covering, wire fencing, pipes, oil well casings, etc., have also proved much more durable when made of wrought iron than when made of steel. On the other hand, in rails, tires, guns, armor plate, etc., steel has proved far superior to iron, owing to its greater strength and hardness, and where corrosion is of minor importance, owing to the rails, etc., generally being worn out long before corrosion has a chance to affect them seriously. When structural steel or iron is used for bridges, etc., it is necessary to protect the metal from serious corrosion by frequent and careful painting, and in the skeletons of high office buildings and other skyscrapers, when completely covered with concrete, etc., so as to thoroughly exclude air or moisture, steel as well as iron will last indefinitely.

Where material is buried in the ground, or exposed to the weather without the careful protection of paint, or where moisture has access to it by other channels, as in the interior of pipes, for instance, wrought iron will outlast steel by a good margin.

* * *

THE HUMAN FRAME AS A POWER PRODUCER.

One of the great problems of the age is the utilization of convict labor in a manner that shall not conflict with the best interests of free labor. From an economical standpoint it is not profitable to any community that its criminals be either idle or engaged on work which is of no material use. Without discussing the ethical and economic features of prison labor further, we may say that about the most ridiculous scheme that we have seen proposed is that of a correspondent of the *American Shipbuilder*, who suggested that convicts be employed to work treadmills to charge storage batteries with which to propel the East River ferry-boats of New York City. It is still further proposed that if the plan were successful, the convicts all over the State be employed in tread-mills for generating electricity for lighting and heating their prison buildings. The correspondent did not mention that the same tread-mills could be used for electrocuting the criminals who suffer capital punishment, but this is a detail which he probably forgot. The author probably did not realize that the human frame as a machine for producing power is of very small effect. The average work done by a man raising his own weight on a stair, ladder or tread-mill is only about 2,000,000 foot-pounds per working day of ten hours, or 1-10 horse-power. Thus, 500 convicts working in a tread-mill would produce only 50 horse-power, and that only for ten hours per day. It does not require a great deal of engineering ability to discover that such a scheme would be practically valueless, being equivalent to saving only 1,500 pounds of coal on the basis of 3 pounds per horse-power hour.

* * *

The daily press reports that the Baldwin Locomotive Works has built a locomotive to the metric system of measurements, and that this feat is a signal triumph for the friends of that system. According to the report, it has always been the favorite assertion of its opponents that the metric system would result in endless confusion where the entire organization of shops and training of men were based on the English system of measurements, but here is a case where the largest locomotive works has built an entire locomotive to the metric system without difficulty. This result really signifies very little, of course. If need be, the locomotive could have been built to the Chinese "fan" or the sailor's knot, or to any other system, with as good success. The item further states that the building of the locomotive necessitated the introduction of many new standards and gages. Now, this is the kernel in the nutshell, and is just the point that the supporters of the metric system minimize. No one doubts but that the metric system can be used in our shops, but its adoption means a very large cost for new gages and tools, and the conversion of English measurements, tables, data, etc., into the metric system. It would take many years for such changes to be effected, for in many cases it would, of necessity, be done gradually, and it is quite doubtful in the minds of those who have opportunity to use both systems that the resulting advantages would be worth a small fraction of the cost of the change.

ON THE ART OF CUTTING METALS.—8.*

FRED. W. TAYLOR.

EFFECT OF FEED AND DEPTH OF CUT ON CUTTING SPEED.

The following are the principal conclusions arrived at on the effect of varying the feed and the depth of the cut upon the cutting speed.

A. With any given depth of cut, metal can be removed faster, *i. e.*, more work can be done, by using the combination of a coarse feed with its accompanying slower speed than by using a fine feed with its accompanying higher speed.

For example, if with a combination of 3/16 inch depth of cut and 1/64 inch feed, the hardness of the metal were of such a quality, for instance, that just 100 pounds of chips would be cut off in an hour, by using the same tool on the same forging at its proper cutting speed corresponding to a feed of ¼ inch, the metal would then be removed at the rate of 250 pounds per hour. In most cases it is not practicable for the operator to take the coarsest feeds, owing either to the lack of pulling power of the machine or the elasticity of the work. Therefore, the above rule is only, of course, a broad general statement.

B. The cutting speed is affected more by the thickness of the shaving than by the depth of the cut. A change in the thickness of the shaving has about three times as much effect

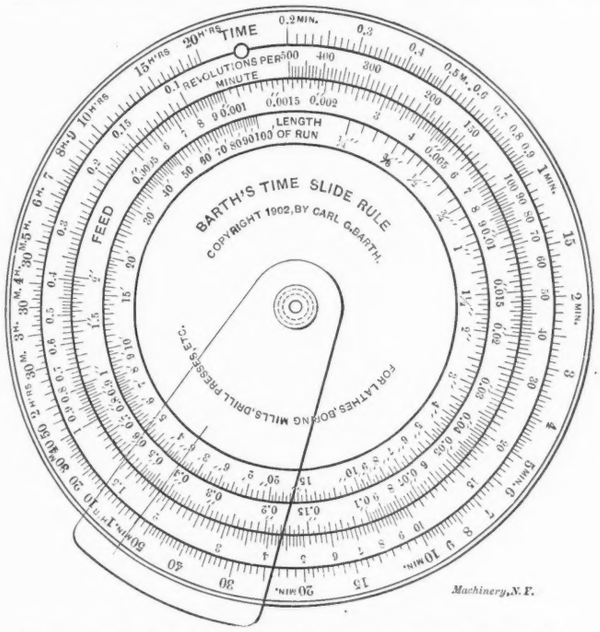


Fig. 48. Barth's Time Slide Rule for Machine Shops, used in Connection with Lathe Slide Rule shown in Fig. 49.

on the cutting speed as a similar or proportional change in the depth of the cut has upon the cutting speed. Dividing the thickness of the shaving by 3 increases the cutting speed 1.8 times, while dividing the length that the shaving bears on the cutting edge by 3 inceases the cutting speed 1.27 times.

C. Expressed in mathematical terms, the cutting speed varies with our standard round-nosed tool approximately in inverse proportion to the square root of the thickness of the shaving or of the feed; *i. e.*, S varies with $\sqrt{F}$, approximately.

D. With the best modern high-speed tools, varying the feed and the depth of the cut causes the cutting speed to vary in practically the same ratio whether soft or hard metals are being cut.

E. The same general formula expresses the laws for the effect of depth of cut and feed upon the speed, the constants only requiring to be changed. This is a matter of very great importance, as it enables us to use a single slide rule as a means of finding the proper combination of speed and depth of cut and feed for all qualities of metal which may be cut.

F. The same general type of formula expresses the laws governing the effect of the feed and depth of cut upon the cutting speed when using our different sized standard tools. This is also fortunate as it simplifies mathematical work in the final solution of the speed problem.

Importance of the Study of Effect of Feed and Depth of Cut upon Cutting Speed.

A study of the effect of the feed and depth of cut upon the cutting speed constitutes, in our judgment, the most important element in the art of cutting metals. As pointed out in the opening paragraphs of this paper (see MACHINERY, January issue) the three questions which must be answered each day in every machine shop by every machinist who is running a metal cutting machine, such as a lathe, planer, etc., are:

What tool shall I use?
What cutting speed shall I use?
What feed shall I use?

Having already established in a shop standards for the shape and quality of the tools, there remain but two of these questions to be answered, namely, as to the cutting speed and the feed. And the decision as to the cutting speed will depend more upon the depth of cut and feed which are chosen than upon any other element.

Tables Giving Cutting Speeds Corresponding to Different Depths of Cut and Thickness of Feed.

In the data sheet are practical working tables which will be found useful by machine shop foremen and machinists as a general guide to determining what cutting speed to use under several of the usual or typical conditions met with in ordinary machine shop practice. The cutting speeds given in these tables are based upon the use of our standard tools for cutting as well hard steel and cast iron as for cutting medium and soft steel. In making these tables we also assumed the use of the best quality of high-speed tool treated in the best manner. The tables were also based upon cutting three different qualities of steel, and the following cutting speeds when cut with our standard ⅞-inch tool, 3/16 x 1/16, for standard 20-minute cut.

Hard steel: cutting speed, 45 feet per minute, such for instance as is used in a hard locomotive tire.

Medium steel: cutting speed, 99 feet per minute.

Soft steel: cutting speed, 108 feet per minute.

The tables made out for cutting cast iron are based upon three qualities of cast iron which we have found representative of hard, medium and soft cast iron as ordinarily found in the average machine shop in this country. In each shop, however, accurate experiments should be made to determine the average cutting speeds of the cast iron actually used.

Best Guide to Hardness as it Affects Cutting Speeds Lies in the Physical Properties of Steel.

The physical properties of steel constitute a fairly accurate guide to its cutting speed; and these properties are best indicated by the tensile strength and percentage of stretch and contraction of area obtained from standard tensile test bars cut from such a position in the body of the forging as to represent its average quality, and then broken in a testing machine.

It is, of course, impossible in most cases for any ordinary machine shop to cut test bars from the forgings which are actually used in the shop. It is, however, entirely possible, and in many cases desirable, to purchase forgings and castings with certain guaranteed tensile strength, stretch and contraction, and thus insure both the superior quality of the metal bought, and at the same time obtain metal practically uniform in its cutting speed. In our search for a guide to the cutting speed of metals, this has proved the only reliable index to the cutting speed.

We have developed the following empirical formula which is at least a partial guide to the cutting speed of steel of good quality when the physical properties of the forging are known as represented by a standard test bar 2 x ½ inch, cut from the body of the forging, and broken in a testing machine.

$$V = \frac{125\left(1 - \dfrac{215}{(15+E)^2}\right)}{\sqrt{\dfrac{S}{10000}} - 3 - 0.9}$$

in which V = standard cutting speed;
S = tensile strength in pounds per square inch;
E = percentage of elongation of specimen 2 inches by ½ inch.

Effect of the Quality or Hardness of the Cast Iron upon the Cutting Speed.

It is much more difficult to predict the correct cutting speed for cast iron than for steel, and as yet no reliable method for doing this has come to our attention.

* Abstract of paper read before the American Society of Mechanical Engineers, December, 1906.

Viewed from the standpoint of chemical analysis, the cutting speed becomes slower the larger the amount of combined or cement carbon contained in the casting, and the cutting speed becomes less the smaller the amount of silicon contained in the casting. The amount of combined carbon, however, depends largely upon the rate or rapidity with which the cast iron has been cooled after being poured into the mold; so that the mixture of the metal in the cupola does not constitute an accurate guide to the hardness of castings.

In cutting almost all qualities of cast iron, the wear on the tool is due to two causes:

a. The abrasive or grinding action of the carbon or gritty matter contained in the body of the iron itself; and

b. the heat generated by the pressure of the chip upon the tool.

In resisting the second of these causes for injury to the tools (*b*), the quality of red hardness tends greatly to increase the cutting speed. However, there is no doubt that the first of the two causes (*a*) plays much the more important part in injuring tools which are cutting cast iron, and in resisting this abrasive action the quality of red hardness is of but little use. For the same reason also, in cutting sand on the outside of castings or a mixture of sand and iron, the high speed tools are but little better than the old-fashioned self-hardening tools.

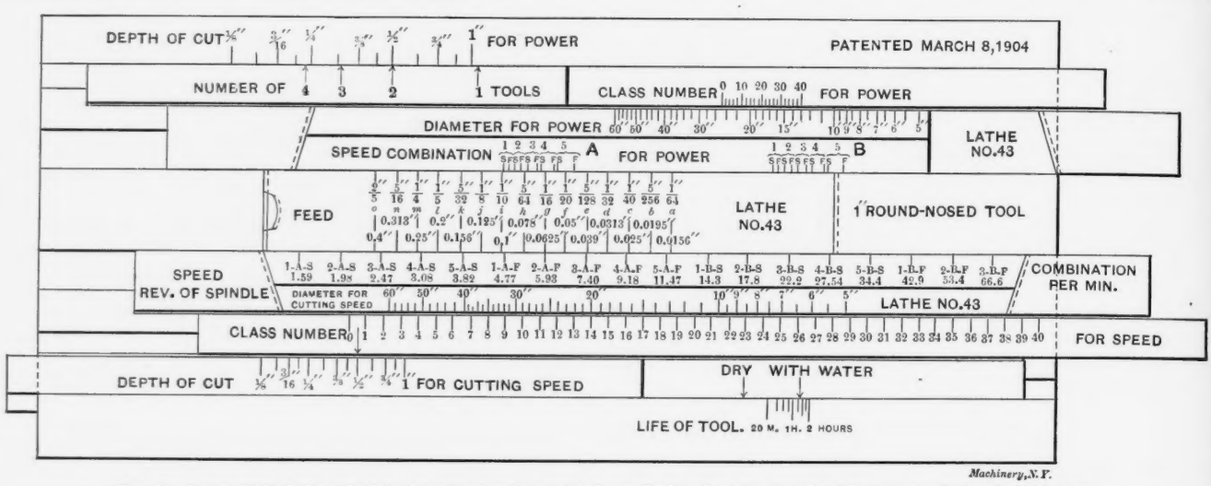


Fig. 49. Lathe Slide Rule embodying the Twelve Important Laws Deduced as the Result of Twenty-six Years' Investigation.

Cutting Speed on Castings as Found in the Average Machine Shop.

As a broad general guide to the cutting speeds to be used for cast iron with the scale on the castings just as they come from the foundry, we would state that as the average of several machine shops in this country, it is our observation that a 3/16 inch depth of cut and 1/16 inch feed, has a cutting speed of 60 feet per minute.

Effect of Scale on Cast Iron Castings upon the Cutting Speed.

As to the effect of the average scale met with in castings in the average shop, our experience indicates that with very soft castings the average scale met with calls for a cutting speed only about one-half as fast as the cutting speed of the same casting below the scale, and that as the castings grow harder and harder, the cutting speed of the scale approaches that of the cast iron below the scale, so that with the castings referred to as "hard" castings, the cutting speed of the scale and of the metal below the scale is about the same. On medium castings, the cutting speed of the scale may be said to be, in general, about three-fourths as fast as the cutting speed below the metal of the scale.

Cutting Speeds of Parting Tools and Thread Tools.

By a "parting tool" we mean a narrow, square-nosed tool which is fed directly "end on" into the work, for the purpose of cutting it or slicing it into two pieces. The two corners of the parting tools experimented with were rounded to the extent of about 1/64 of an inch.

By a "thread tool" we mean the ordinary tool for cutting the United States Standard V Threads, having a 60 degree included angle. The extreme point of this thread tool was also squared off to the extent of about 1/64 of an inch.

The ratio of a thread tool to a tool with a straight line cutting edge under the same conditions, that is, when both were fed with the same feed, "end on," straight into the work, was found by two experiments to be as 0.45 : 1.

The practical problem, however, for the man who is running a machine shop, is to find quickly, when he has a given quality of metal, at just what speed he must run his parting tool or his thread tool to do the work with the greatest economy; and we would suggest the following as a practical rule for obtaining the desired cutting speed.

Referring to the data sheet tables for cutting steel and cast iron, find first the feed, *i. e.*, the thickness of the chip which is to be cut by the parting tool; then look in the table for cutting steel or cast iron as the case may be, for our standard 7/8-inch tool under 3/16-depth of cut and with the thickness of the feed which corresponds most nearly to the given thickness of the chip which is to be taken by the parting tool; read off the cutting speed from this table, and divide it by 2.7, and this will give the proper cutting speed for the parting tool.

In other words, if we take the practical economical cutting speed of our 7/8-inch standard round nosed tool when using 3/16 inch depth of cut and a feed which is the same as the thickness of chip to be cut by the parting tool, the speed of our standard tool under these conditions will be 2.7 times as fast as the proper speed for the parting tool.

If in the same way we first determine the thickness of the chip over the point or extreme nose of the thread tool, *i. e.*, if we determine the exact advance of the thread tool toward the center line of the work each time a cut is taken, and call this advance the thickness of the chip; and if we then proceed as described just above in the case of the parting tool, it will be necessary to divide the speed obtained for our standard round-nosed tool by 4. Or, in other words, if we take the practical economical cutting speed of our 7/8-inch standard round-nosed tool when using a 3/16 inch depth of cut and a feed which is the same as the advance of the thread tool toward the center line of the forging which is made after each cut taken by the thread tool, the speed of our standard tool under these conditions will be four times as fast as the speed of the thread tool.

* * *

A syndicate is flooding the country newspapers with direful accounts of the failure of municipal ownership of public utilities. It is quite affecting to see how considerate certain people are of others' welfare, and to note their strenuous efforts to keep cities and towns from dabbling in that which will burn their fingers. One cannot help thinking, however, that there may be something of selfish interest in it all. Unfortunately for the spread of municipal ownership there are no subsidized press agents to sing its praise.

CUT OUT OF THIS LINE

CUT OUT ON THIS LINE.

PUNCH PUNCH

These operation sheets, covering every class of shop work, are a feature of all Editions of MACHINERY, and appear every month. They may be cut along the top and margin lines for filing and binding. Suitable binders of sufficient capacity to hold four years' issues will be supplied by THE INDUSTRIAL PRESS, 49-55 Lafayette Street, New York, for 25 cents each, including postage.

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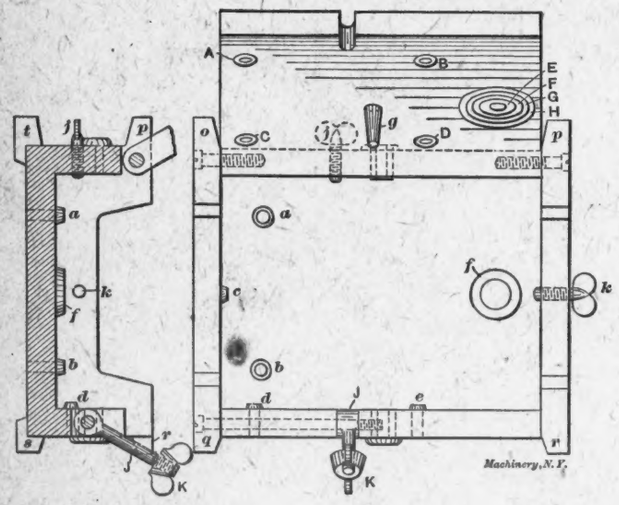
SHOP OPERATION SHEET NO. 10.

Oscar E. Perrigo. MACHINERY, August, 1907.



To Clean and Prepare a Drill Jig for Use, and Clamp the Piece of Work Therein.

NOTE.—A plan of a "box jig" is shown above, with the cover opened, as it would appear after removing the last casting drilled in it. At the left is a cross-section of the jig in the same condition. The work is a stiff casting, so the jig is comparatively simple in construction, without the refinements necessary to prevent distortion of slender work.

1. Clean the jig thoroughly by brushing out all chips and dirt from its inside, and particularly from the contact points *a*, *b*, *c*, *d*, *e*, *f* and *g*, and the surfaces where the lid shuts, so that it will close accurately.

2. See that the removable bushings, *A*, *B*, *C*, *D*, are in place and pushed down to their shoulders.

3. See that the compound bushings, consisting of the bushings *E*, *F*, *G*, *H*, one inside of the other, are clean and pushed down into place.

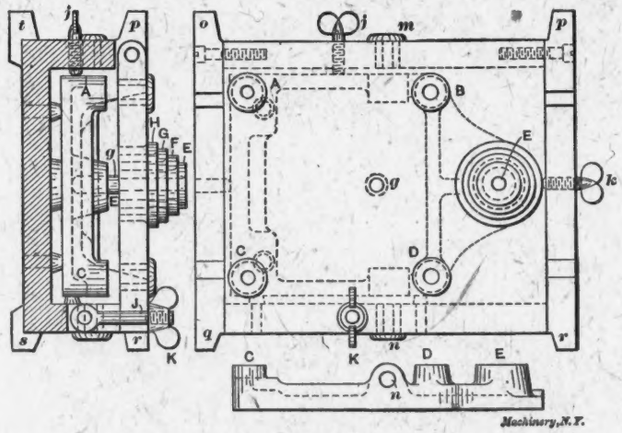
4. Place the casting in the jig, the bottom resting on the contact pins *a*, *b*, and the contact circle *f*. Press the front side against the contact pins *d*, *e*, and the broad end against the contact pin *c*. Screw up lightly the binding screws *j* and *k*.

5. Close the lid and see that the pressure pin *g* rests fairly on the casting. Swing up the pivoted lock-bolt *J* and screw down the nut *K* lightly.

6. Screw up successively the binding screws *j*, *k*, and the lock-bolt nut *K*.

SHOP OPERATION SHEET NO. 11.

Oscar E. Perrigo. MACHINERY, August, 1907.



To Drill Vertical and Horizontal Holes in a Casting, as Provided for by the Jig.

NOTE.—A plan of the jig is shown above, with the cover closed. The casting to be drilled is shown in dotted lines. A cross-section is shown at the left in which an end elevation of the casting is given. The bushings *E*, *F*, *G* and *H*, composing the compound bushing, are shown in place inside of each other. If desired, these bushings may be made without reference to each other, each being large enough on the outside to fit the hole in the jig body. Both methods are in use, and both represent good practise.

1. Fasten in the spindle of the drill-press a drill of suitable diameter for the holes at *A*, *B*, *C* and *D*, and with the jig lying on the drill table, lid-side up, proceed to drill these four holes.

2. Change the drill for one of the proper diameter and drill the hole at *E*.

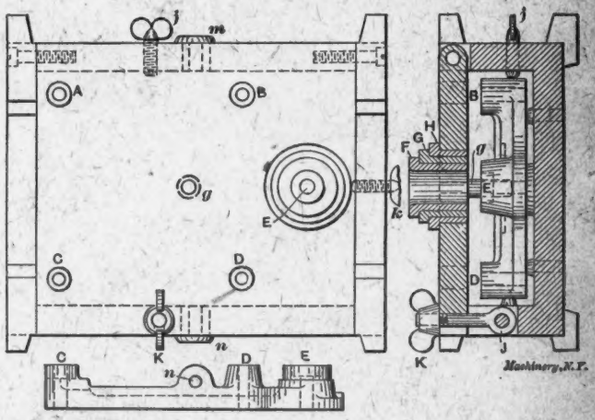
3. Change the drill for one of proper diameter; turn the jig on its edge, and drill the hole at *m*.

4. Reverse the jig on its opposite edge, and drill the hole at *n*.

NOTE.—Be careful that the drill table is brushed off clean, and that the jig feet *o*, *p*, *q*, *r*, *s* and *t* rest fairly on the drill table, with no dirt to interfere with its solid bearing; otherwise poor work and broken drills may be the result. A jig with a three-point bearing on the table should never be used, as it is difficult to tell whether or not it is fairly seated. If a drill press with three or more spindles is available, the tools used in Steps 1, 2 and 3 may be permanently held in them, avoiding the frequent changes otherwise necessary.

SHOP OPERATION SHEET NO. 12.

Oscar E. Perrigo. MACHINERY, August, 1907.



To Tap, Ream, Counterbore, Face and Size a Boss on a Casting, as Provided for by the Jig.

NOTE.—The four holes *A*, *B*, *C* and *D* are to be tapped; the hole *E* to be reamed and counterbored; the boss *E* to be faced, and its diameter finished in size. The work is supposed to be in place, with the holes drilled.

1. Remove the bushings *A*, *B*, *C* and *D*. Change the drill-holder for a tap-holder. Put in the proper tap, reduce the speed, and proceed to tap the holes *A*, *B*, *C* and *D*.

2. Remove the tap-holder. Remove the drill bushing *E*, leaving bushing *F*, as shown in the end section. Put in a drill-chuck, in which place a reamer of proper diameter, and ream the hole at *E*.

3. Remove the reamer and put in a counterbore of proper diameter, provided with a stop collar to govern the depth. Counterbore the hole at *E*. (The counterbore is steadied by the bushing because the reamed hole is not large enough to guide a pilot strong enough to insure good work.)

4. Remove the bushing *F*. Remove the counterbore and put in an end mill of diameter to fit the bushing *G*. With a stop collar to govern the depth, face off the boss *E*.

5. Remove bushing *G*. Remove end-mill and put in a hollow end-mill of diameter to fit bushing *H*, and recess to size the boss *E*. Use a stop collar to govern the depth. Finish the outside of boss *E* as shown.

NOTE.—The stop collars used on these tools may be fixed by a set-screw, and adjusted so as to stop against the top of a bushing and so determine the depth. If a drill-press with five or more spindles is available, the tools used in Steps 1 to 5 may be permanently held in them, avoiding the frequent changes otherwise necessary.

PERSPECTIVE AND ISOMETRIC DRAWING.*

FREDERIC R. HONEY.†

In my last contribution to MACHINERY, January 1907, I referred to isometric projection as one of the means of representing an object pictorially, that is, to give to the ordinary observer a clearer idea of its form than that which is conveyed by its plan and elevation. For this reason this method has sometimes been described as "isometric perspective"—an

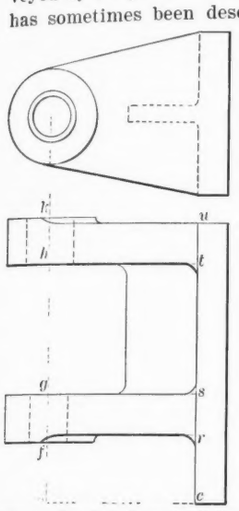


Fig 1. Bracket shown in Orthographic Projection.

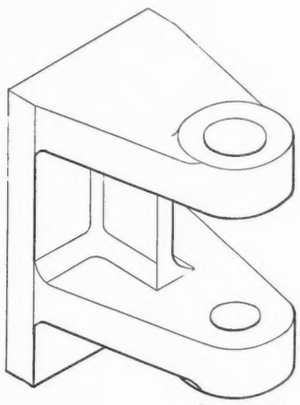


Fig. 2. Same Bracket shown in Isometric Drawing.

erroneous expression, because perspective and isometric drawing are distinctly different methods of representation. A perspective drawing, correctly constructed, presents to the observer from a given point of sight the same apparent outline as that of the object itself, while an isometric projection is a distorted representation. This distortion increases with the increase of the dimensions of the object, and may convey an inaccurate idea of its real form and proportions.

The object selected here to illustrate these different methods is shown in Fig. 1, in which, in reduced scale, are two views of a casting for carrying the worm which operates the turning gear of a triple-expansion engine, the dimensions of which are taken from "Machine Drawing and Design" by Low and Bevis. In Fig. 1 the piece is shown in the position it occupies when bolted to the frame of the engine, *i.e.*, the axis of the worm is vertical. Fig. 2 is an isometric drawing of Fig. 1. The principal axes form angles of 120 degrees with each other, and real measurements are laid off upon them. It would not be correct to call this an isometric projection, because certain dimensions should be diminished to a little over four-fifths of their true length. The precise length of the isometric scale is shown in Fig. 5, which is constructed as follows: Draw the 45-degree line $a\,b$ equal to the length of an ordinary scale, we will say 12 inches; from one end draw the 30-degree line $a\,c$ and draw the perpendicular $b\,d$ intersecting $a\,c$ at c. The line $a\,c$ is the true length of the isometric scale of 12 inches, which may now be divided into inches and parts. The length of $a\,c$ may be computed as follows: Multiply 12 inches by the cosine of 45 degrees and we obtain the length of $a\,d$. If $a\,d$ be multiplied by the secant of 30 degrees we have the length of $a\,c$. Thus, $12 \times \cos 45° \times \sec 30° = 12 \times 0.7071 \times 1.1547 = 9.798 =$ 9 4/5 inches.

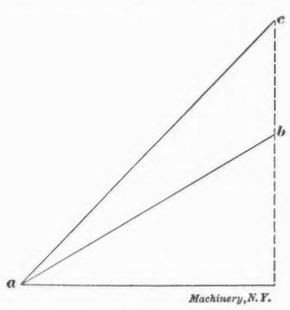


Fig. 3.

Fig. 2 is therefore the projection of a figure whose dimensions are greater than those shown in Fig. 1. But all the dimensions are shown in their natural length, and thus the figure is drawn at once, avoiding the change from the ordinary to the isometric scale. This system has the advantage also of representing in their true value the principal dimensions of the object, *i.e.*, those dimensions that are parallel to the coordinate axes.

It should be noted that the major axis of the ellipse which represents a circle, should be longer than that which is laid off when the isometric scale is employed. Its length is easily found as follows: Lay off the true length of the diameter of the circle on the 30-degree line $a\,b$, Fig. 3, and the perpendicular from b will intersect the 45-degree line $a\,c$ at c. The line $a\,c$ is the required length. The circles are treated in this way in Fig. 2, which may be described as an "isometric drawing" as distinguished from an isometric projection of Fig. 1.

Whenever it is necessary to represent circles in this kind of projection, the drawing of ellipses is unavoidable in whatever position the object is placed. Since it is desirable to avoid these constructions whenever possible, the draftsman should make a perspective drawing of the object in the position, Fig. 4, in which the circles are parallel to the plane of the paper, and are easily drawn in perspective, because in each case the perspective of the circle is a circle. In this position is obtained a view of the object that satisfies the eye. When it is at the right distance from the drawing, the apparent outline is precisely the same as that which would be observed if the object itself were placed before the draftsman. Therefore it is obvious that this mode of representation is preferable to the isometric drawing.

In Fig. 4 the lower end of the casting is turned toward the observer, and the rectangle $a\,b\,c\,d$ is shown in its true dimensions. The center line $e\,o$, drawn perpendicular to $a\,b$ at its

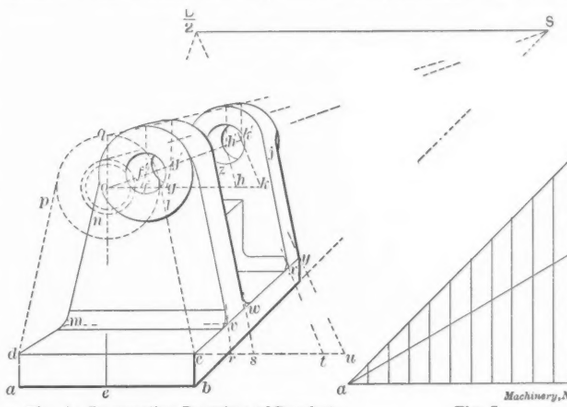


Fig. 4. Perspective Drawing of Bracket.

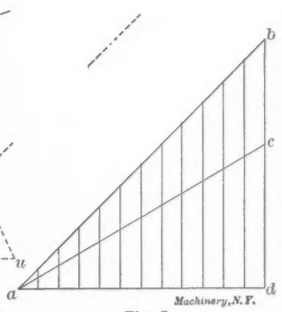


Fig. 5.

middle point, is made equal to the corresponding measurement in Fig. 1. The horizon is drawn at any assumed distance above the object, and the distance from S to $\frac{D}{2}$ measures one-half the distance from the eye of the observer to the paper. From o, the center of the circles, draw a line to S and a horizontal line. On the latter lay off $o\,f$, $o\,g$, $o\,h$ and $o\,k$ equal respectively to one-half of $o\,f$, $o\,g$, $o\,h$ and $o\,k$ in Fig. 1, *i. e.*, in each case one-half of the distance between the center of the circle and the plane containing the rectangle $a\,b\,c\,d$.

From f, g, h, and k, draw lines to $\frac{D}{2}$ intersecting $o\,S$ at f', g', h' and k', the centers of the perspective circles whose radii are determined by drawing a line from q to S intersecting perpendiculars from these centers. From these centers describe the four circles, two of which will be limited by tangents which are drawn as follows: Produce the line $d\,c$ and lay off $c\,r$, $c\,s$, $c\,t$ and $c\,u$ respectively equal to one-half of $c\,r$, $c\,s$, $c\,t$ and $c\,u$ in Fig. 1. From r, s, t and u, draw lines to $\frac{D}{2}$ intersecting $c\,S$ at v, w, x and y. From w and x draw the parallel tangents $w\,z$ and $x\,j$, and from v and y draw parallels to these tangents. These lines are also parallel to $c\,l$. With the aid of the drawing the draftsman will easily complete the perspective.

It should be noted that the smaller circles are constructed

*The following articles regarding perspective and oblique projections have previously been published in MACHINERY: Notes on Isometric Perspective, October, 1904; The Practical Perspective, September, 1904; Perspective vs. Oblique Projections, January, 1907.

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in the same manner as those already described, and the line *m n* is drawn parallel to *d p*. To avoid confusion, invisible lines are omitted, but these may be added after erasing the construction lines. To make a perspective drawing rapidly, the object should be placed in a position which makes it easy to draw the lines with a minimum of mechanical work. The foregoing is selected partly to illustrate this point. Circles are represented by circles, and all those lines that are parallel to the plane of the paper are represented by parallel lines.

In isometric drawing, the larger the dimensions of the object, the more marked is the distortion. In perspective drawing, the eye is perfectly satisfied with the form because it correctly represents the apparent relative positions of every point and line.

* * *

SIMPKINS AND HIS HAND-BAG.

M. E. CANEK.

Simpkins was a mechanic—a tool-maker if you please. His wife bought a small hand-bag to carry his lunch down to Berg's big machine shop, across the river—it looks so much more genteel that way, you know. That night Simpkins looked the bag over, tried its weight, and filled it with

"Learned that down in Baxter Street, New York."

some odd junk to see how it carried. The catch did not hold; when the bag was full it had a very disagreeable and startling way of opening and showing the contents to all beholders. Certainly, it would never do to have his lunch displayed to the sneering passers-by when walking down Main Street. Simpkins looked at the catch with a mechanic's eye. He wanted to use the bag the next day, but did not like the job of fixing it. Bag-makers have such a foolish way of fastening everything with rivets and "turn-overs," which break off when you try to straighten them out. So he gave it up, and carried his dinner in the old lunch-box, taking along the bag to exchange it for another on his way down town.

"Say, Jones, that bag you sold my wife is N. G. Catch won't hold."

"Don't hold, eh. Let's see it. Humph! I'll fix that in a shake of a lamb's tail."

Suiting the action to the word, Jones, who hardly knew a hand-saw from a monkey-wrench, seized an old pair of pliers that lay on the counter and gave the two dinky little hooks a slight twist around to starboard, and lo! the job was done.

"Learned that down on Baxter Street, New York," said Jones, beaming on poor Simpkins as he handed the bag over the counter.

"Good scheme," said Simpkins weakly, and walked out, thinking as he went: "Even if you are a tool-maker, handling a micrometer is not everything in the mechanic's trade. There are lots of tricks that you don't know yet."

OIL ENGINES.*

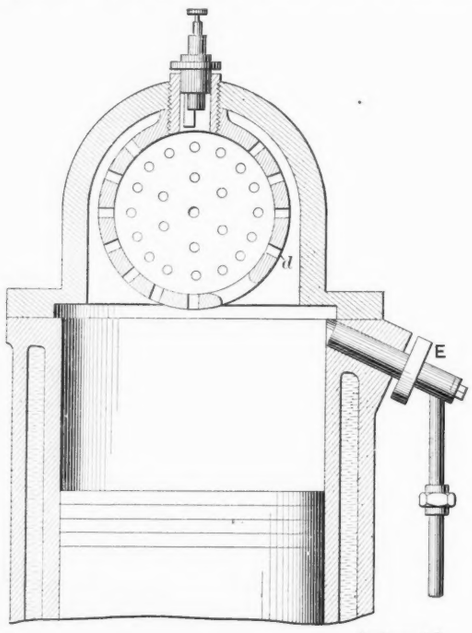
S. M. HOWELL.†

S. M. Howell.‡

The production of power by the combustion of crude mineral oil in the cylinder of a gas engine is a problem which has been persistently followed by many inventors; and to a great extent their efforts in this direction have been successful. This is true at least as regards stationary engines in certain situations, where the use of oil fuel is convenient or desirable on account of local conditions, such as proximity to the great oil fields, or in isolated places not supplied with gas, and in buildings which would be endangered by the presence of gasoline or other highly inflammable liquids. But there is also another field for the oil engine whenever it can be made to meet the requirements. The well-known gasoline engine has heretofore been relied upon exclusively in this country as the motor for small boats, automobiles and other self-propelled vehicles; but the growing scarcity of gasoline has made its more limited use for this purpose a matter of economy, if not a measure of necessity. Herein is the opportunity for the oil engine. An automobile, however, requires a motor of great flexibility and ease of control under wide variations of speed and load, and the use of oil engines in this way has only recently been attempted.

No Essential Difference in Operative Principles of Internal Combustion Motors Using Oil and Gasoline.

As regards operative principles there is no essential difference between an oil engine and an engine made to use gasoline, but there is an important difference in the character and properties of the respective liquids, and the difficulties encountered in the design of a successful oil engine exist in the nature of the fuel. Mineral oil in its crude state is in reality a complex combination of various liquid and solid



Machinery, N.Y.

Fig. 1. G. A. Phail Kerosene Engine, Pat. No. 743,097, Nov. 3, 1903.

* The following articles regarding oil engines and kindred subjects have previously been published in MACHINERY: The Oil Engine, September, 1898; The Commercial Advantage of the Oil Engine, June, 1899. An Interesting Engine, May, 1899; Patents in their Relation to the Gas Engine and the Automobile, January, March, and May, 1906 (engineering edition).

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‡ S. M. Howell learned the machinists' trade and art of mechanical drawing at the Baldwin Locomotive Works and Spring Garden Institute at Philadelphia, Pa., in the years from 1889 to 1893. His present occupation is largely the designing of engines and special machinery, and the mechanical development of patents. He has had a wide range of experience, having been employed by a number of prominent machine-building concerns.

hydrocarbons, and these constituents vary greatly in their relative proportions to each other in the several grades and qualities of oil as found in different localities. But for practical purposes in the present instance we may say that crude oil is in general a mixture of either asphaltum or paraffine with kerosene and gasoline. These substances when separated by distillation form the commercial products of the oil refinery. Crude oil is, of course, cheaper than the refined product, and is in many localities abundantly available; but the refined article known as kerosene is in such well-established use as to have become a staple article of retail commerce in all parts of the world, and may readily be procured at all times in any locality. Its cost per gallon is considerably less than that of gasoline, and its fuel value is higher. Its comparative cost per unit of fuel value probably does not now exceed one-half that of gasoline, and this difference bids fair to grow wider.

It should be remembered, however, that kerosene is not so rapidly inflammable as gasoline or alcohol, requiring a little more time for its combustion. Therefore a kerosene engine will not run at the high speeds now used in automobile practice with gasoline. Kerosene, moreover, requires heat for its vaporization. Heated air having a temperature of about 500 deg. F., drawn through a carbureter supplied with kerosene, will absorb the liquid and form an explosive mixture, there being several oil engines now on the market operating in this way, and in a few cases said to be driving automobiles. In

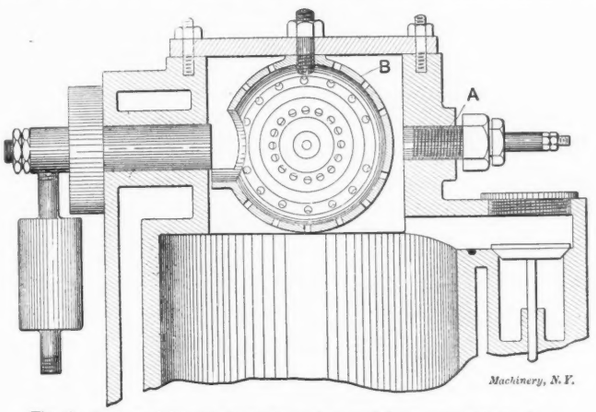


Fig. 2. N. L. and W. W. Tuck Vaporizer and Igniter for Oil Engines. Pat. No. 762,960, June 21, 1904.

order, however, that the engine may be started, an auxiliary device, consisting of a small closed vessel containing gasoline, must be used. This is connected with the vaporizer and arranged in such a way that when the engine has been started and run for a few minutes, the gasoline may be switched off and the oil instantly turned on by the motion of a lever. Only a small quantity of gasoline is required for this, merely a few spoonfuls being used at each time of starting. A few revolutions of the engine on gasoline will heat the vaporizer sufficiently to make the oil fuel at once available. The air receives its heat from the exhaust, and becomes hot before coming in contact with the oil in the carbureter. This is a practical and easy method of using kerosene in a gas engine, and is quite reliable. In the case of an automobile engine, the gasoline auxiliary may be quite small and compact, containing say a quart or two of the liquid, which should suffice for starting purposes for several days.

Internal Vaporizer Type Engines.

Another style of oil engines is that known as the internal vaporizer type. In these engines no outside heating device for the air is required, but the gasoline auxiliary just described, or some equivalent means of preliminary heating, must usually be employed. In these engines the oil is injected into the cylinder as the air enters, or in some cases during the return or compression stroke of the piston, in the latter case being sprayed in by a small stream of air under pressure. By this means the oil is atomized and enters the cylinder in the form of a mist which strikes the heated head or some part of the internal surface, and is thereby still further reduced or completely vaporized and mixed with the air. To this class belong the following engine types.

The Phail Kerosene Engine.

Fig. 1 shows the vaporizing device of the Phail engine, consisting of a hollow cast iron ball within a dome-shaped projection of the cylinder or its head. This ball is perforated with numerous small holes, and also has a larger opening shown near the bottom through which the oil reaches the interior of the ball, injected by a small pump at *E*. The oil is forced in

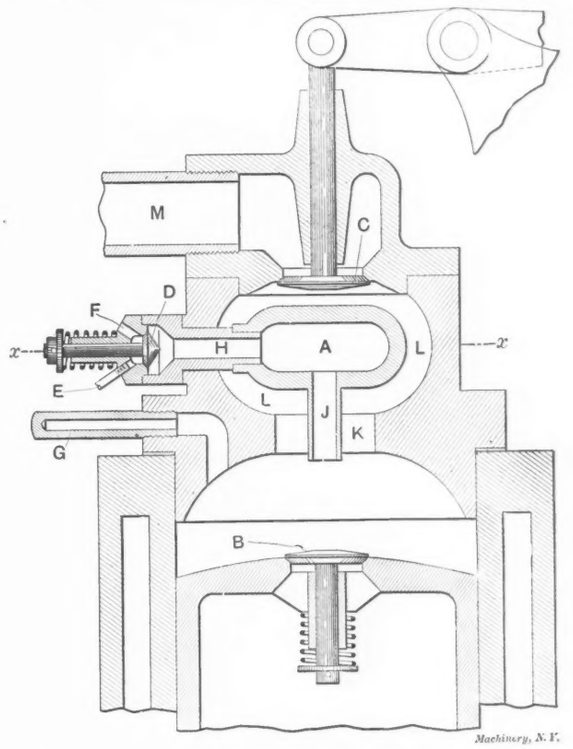
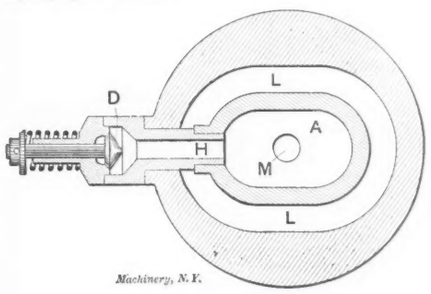


Fig. 3. V. V. Torbensen Oil Engine, Pat. No. 653,854, July 17, 1900.

during each compression stroke of the engine piston, and the ball is kept at a high temperature by the heat of the explosions. The engine is of the two-cycle type, the air being received at the beginning of each compression stroke through a port not shown in the drawing. The exhaust takes place in a similar manner through another piston-operated port opposite the air-inlet as usual in two-cycle engines. The compression stroke of the piston drives the air through the small holes into the red-hot ball, where it meets the entering spray of oil and thoroughly gasifies it.



SECTION *x*—*x*

Fig. 4. Section in x—x of Oil Engine in Fig. 3.

This patent is somewhat remarkable for its brevity, and the restricted nature of its claims. These are three in number, and each is limited by the inclusion of an electric igniter within the hollow ball. Therefore, if the igniter was placed outside the ball or the ignition was effected by other means than that of the electric spark, such a device would not come within the limitations of the patent. The engine is, however, regularly manufactured by a large firm, and is extensively used for stationary power in small units. It is highly efficient, and will vaporize and consume kerosene completely.

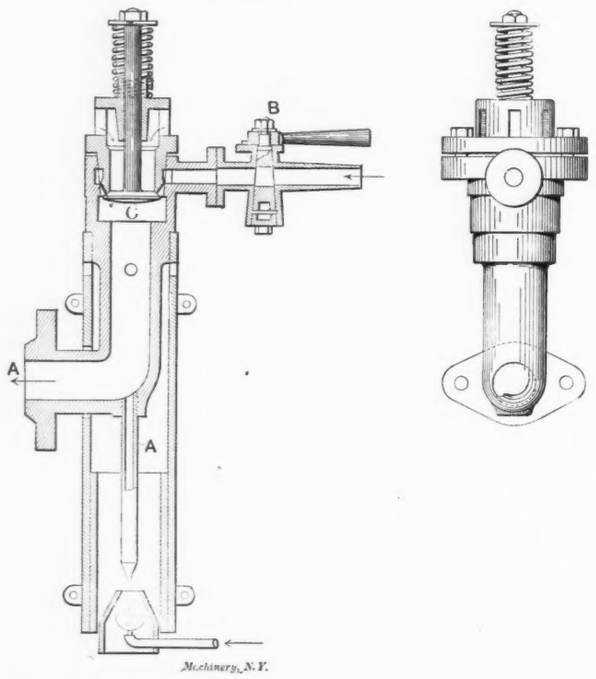
The Tuck Engine.

Another similar construction is the Tuck patent, shown in Fig. 2. In this patent the electric igniter *A* is outside of the

perforated ball vaporizer *B*, and the inventor states that after the engine has been started, electric ignition is dispensed with, the charge being fired automatically by the heat of the vaporizer. This method of ignition is very commonly used also in many other engines of this class.

The Torbensen Engine.

The Torbensen patent illustration is shown in Figs. 3 and 4, in which *A* is the familiar internal vaporizer. *B* is the air admission valve located in the piston, which opens and closes automatically by the preliminary compression of the air in the crank-case. *C* is the exhaust valve, and *D* the oil admission valve. The oil enters through pipe *E*. *F* is an opening to the atmosphere. This opening also leads to, and is controlled by, the oil admission valve *D*. *G* is the ignition tube, which is used only for starting. This tube is first heated by a torch in order to ignite the first few charges, after which the torch is removed and ignition effected automatically by the heat of the vaporizer. The out-stroke of the piston draws open the oil admission valve, and also the air admission valve *B;* the oil enters and passes the valve *D* in company with a small stream of air entering at *F*. The air takes up the oil and carries it as fine spray through the passage *H* to the vaporizer *A*, and thence through the tube *J* to the interior of the cylinder, where it meets a much larger volume of air entering by the valve *B* in the piston. The atomized oil having been thus highly heated by its passage is now thoroughly mixed with the main body of the air charge, and exploded at the termination of the compression stroke by contact with the hot surfaces of the vaporizer. The exhaust escapes through the passage *K*, into space *L*, around the vaporizer, and thence to the atmosphere by the valve *C* and pipe *M*.



Figs. 5 and 6. H. Campbell Oil Engine. Pat. No. 523,511, July 24, 1894.

Fig. 4 is a cross section on line *x-x* of Fig. 3. This is a very successful oil engine, and when once started will run reliably under a considerable variation of speed.

The Campbell Oil Motor.

This is a four-cycle engine. The oil is drawn into the cylinder in the form of a spray through a heated vaporizer, along with the air, at each alternate stroke. The finely-divided oil, thus injected, is well gasified by mixture with the air and contact with the heated walls of the cylinder during the suction and compression strokes. Fig. 5 is a section of the air and oil admission valve and its casing, which the inventor terms the vaporizer, but which is in reality a mixer or spraying device. The vaporization takes place mainly within the cylinder by contact with the internal surfaces and by mixing with the heated air of the charge, assisted by the churning action of the piston. Fig. 6 is a front elevation, and Fig. 7 shows the cylinder in section with the exhaust valve and its actuating mechanism.

In Fig. 7, *F* is the exhaust valve, and *D* is the base of the vaporizer, where it joins the cylinder head, at which point the mixed oil and air enter the cylinder, as shown by the curved arrow. The ignition is by means of a hot tube shown at *A* in Fig. 5.

The oil is admitted by the valve *B*, Fig. 5, and enters the vaporizer through the small holes in the seat of the air valve *C*, when the latter is drawn open by the suction of the piston. The oil and air thus mixed pass through the vaporizer into the cylinder at *D*, Fig. 7. The return of the piston compresses the mixture and forces it back into the hot-tube *A*, by which

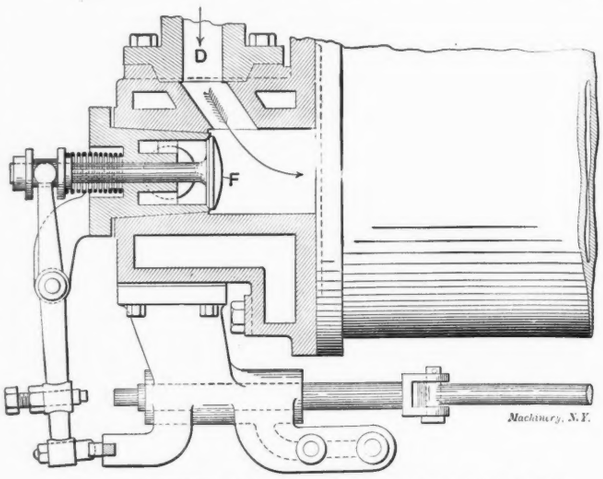


Fig. 7. H. Campbell Oil Engine. Pat. No. 523,511, July 24, 1894.

it is ignited, and the power stroke produced. This system with various modifications has been well tried, and is quite successful for stationary power.

The Diesel Engine.

This famous construction is perhaps the most scientific form of oil motor known, and it is also very successful in practice. Its development was in fact one of those rare instances in which a fine theory conformed easily to the requirements of practical use. There is a number of Diesel patents covering various details of construction, but the original one upon which the operative principle of the engine is based is the German patent of February 28, 1892, R. Diesel, No. 67,207. Patented also in the United States July 16, 1895, R. Diesel, 542,846. This invention is so widely and favorably known that an illustration of it here is deemed unnecessary, but a full description may be had by reference to the above named United States patent. The engine is used principally for stationary power in large sizes. As regards fuel consumption, it is the most economical oil motor known.

The above described systems may be taken as fairly representative of those methods of oil engine construction which have been found practical, and have been made the basis of successful manufacture, but there are several others, and the subject is one which is open to many further improvements. A common means of gasifying the oil, which does not necessarily involve the use of patented devices, is to use a cast iron retort of ample size, highly heated by the exhaust, and so arranged that it may be readily cleaned out. The oil is fed into this retort, and the vapor or gas conducted to the engine cylinder. This plan is largely used in localities where the native oil has an asphaltum base.

In the case of stationary engines running under nearly constant loads at a regular speed, oil engines have in numerous instances proved entirely satisfactory, but the automobile motor is a somewhat different, and in some respects more difficult, problem, requiring reliable action under rapidly-changing conditions; and it is only recently that any degree of success has been attained with the oil engine thus used, but there are great inducements and good opportunities for further improvement. Kerosene or common lamp oil is the kind most suitable for this purpose.

LETTERS UPON PRACTICAL SUBJECTS.

MAKING A MASTER PLATE AND USING IT FOR A DIE.

The writer has always entertained considerable respect for the height gage and buttons for accurately locating holes in jigs, dies, etc., but the accompanying description of locating the holes is, in my opinion, still more accurate. Recently we had to make a die for a register plate having 15 small holes, 0.040 inch in diameter. These holes were for a train of small clock wheels having very fine teeth. There are four dies in use in four different cities, producing this same plate, and consequently great care was exercised in making the die. When the drawings arrived we found that, instead of giving the dimensions from center lines each way to the holes, they were given by radii, as will be noted in Fig. 1, where the center distances of the clock wheels are given. The dimensions were carried out to ten-thousandths inch.

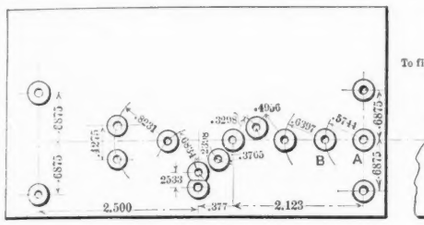


Fig. 1

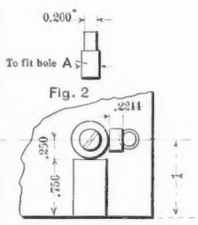
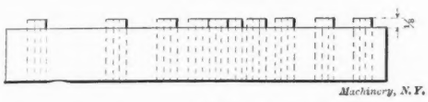


Fig. 3

Fig. 2



Making a Master Plate.

We all know that, when using the height gage, skill is required in handling the tool, as one must be governed by the sense of touch, and no matter how skillful a man may become in using this tool, it is impossible to accurately divide thousandths of an inch. But, had the dimensions been given from center lines, we undoubtedly would, nevertheless, have depended for accuracy on our skill with the height gage and our ability to "guess." This latter trait, however, is a poor one to cultivate in our business. We could, of course, have figured the angles and obtained the dimensions from the center lines, but chances of errors would then have been greater. We therefore decided to make a master plate, and after getting the holes exactly right, make the die from that, and we proceeded in the following manner:

First we obtained our starting point. By referring to Fig. 3, we note that the dimension from the edge to the center line is one inch. By using a button exactly 0.500 inch in diameter and making a spacer exactly 0.750 inch long, we were sure that the center of the button was one inch from the edge. The button was indicated true at *A*, and the hole bored, and a plug, Fig. 2, was turned and placed in the hole. The next hole, *B*, is on the center line, and the distance is 0.5744 inch from *A*. One-half the diameter of the plug in the hole *A* is 0.100 inch, and one-half the diameter of the button is 0.250 inch. Therefore, take the sum 0.350 from 0.5744 and it leaves 0.2244 inch, which is the distance from the edge of the button to the edge of the plug. By grinding a piece of soft steel exactly 0.2244 inch thick, and using the 0.750 inch spacer, we locate the button for the second hole as shown in Fig. 3. The button is located and the hole bored in same manner for each case until the completion of the master plate. This method is very accurate, but requires a little more time than some other methods not quite so accurate. It was our intention to insert hardened, ground and lapped bushings in the master plate, all bushings to have same size holes. Then, by soldering the die plate to the master plate and turning a plug in the center of the face-plate of the lathe to fit the holes in the bushings, the master plate could be located on the plug and strapped to the face-plate, and the die could be spot drilled and bored. The holes would then be exactly in line with the holes in the master plate. After the die was completed, the master plate could be laid away for duplicating the die, thereby saving time on the next die. But, instead of putting in bushings and making a die in this manner, we put in *bushings having holes 0.040 inch, as called for*, and, by making the bushings ⅛ inch longer than the thickness of the master plate, we were enabled to use the master plate for a die. When the bushings are ground away flush with the master plate, all that is necessary is a new set of bushings. This method may be in vogue in some shops, but it is new to the writer, and there may be many that it will benefit.

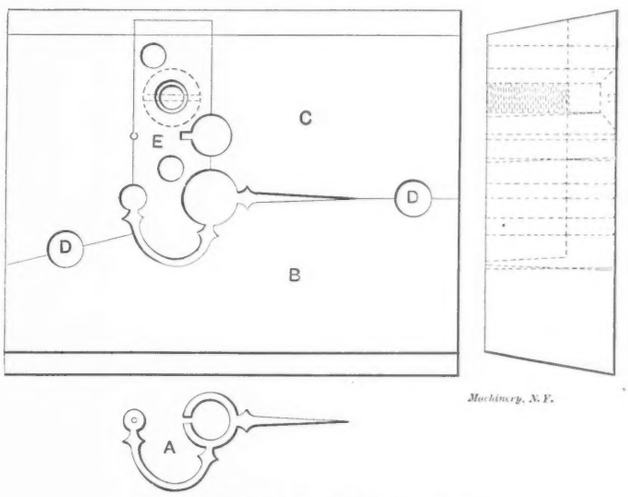
In regard to the master plate being injured by using it to make the die therefrom, would say that all first-class shops, especially watch factories, first make a master plate as nearly perfect as possible, and then make dies, jigs, gages, etc., from the master plate, the latter sometimes being termed templet. But, when used in this manner, the holes are, of course, fitted with hardened, ground, and lapped bushings. All bushings have the same size holes to permit one plug in the face-plate to answer for all holes. The master plate when converted into a die, as previously described, stands very little chance of being injured sufficiently to affect the truth of the distances between the holes, because of the fact that the bushings fit snugly the entire thickness of the master plate, which is made extra heavy. The holes in the bushings are but 0.040 inch in diameter and therefore there is but little strain on the plate.

F. E. SHAILOR.

Great Barrington, Mass.

SPLIT DIE FOR WATCH REGULATOR.

Much has been said of late regarding the advantages of the split die, and to no class of work does it apply more practically than to the blanking of watch movements, not only the second, minute and hour hands, but to many other parts as well. Many parts, owing to their extreme smallness and intricate shape, would be very hard indeed, if not impossible, to make in a solid or one-piece die. The accompanying cut shows a die of the common tandem type, which was made for blanking a regulator such as is used in the manufacture



Split Die, and Work for which it was Used.

of one of the popular cheap watches, and requires but little explanation. The part *A* is the blank, which is of 0.015-inch sheet steel. The two halves of the die, *B* and *C*, were nicely machined together, and it was not found necessary to grind the two together, the slight warping occasioned by hardening being practically overcome by keying the die securely in the die bolster. This was made special, and the die is never removed. The two dowel pins *D D* locate the two halves and prevent any shifting endwise. The section *E* is inserted from the side and held in place by a screw and dowels. In planing out the die for this part, the tool should have its corners rounded so as to leave slight fillets in the corners. I have seen many dies break in hardening through the failure to take this precaution.

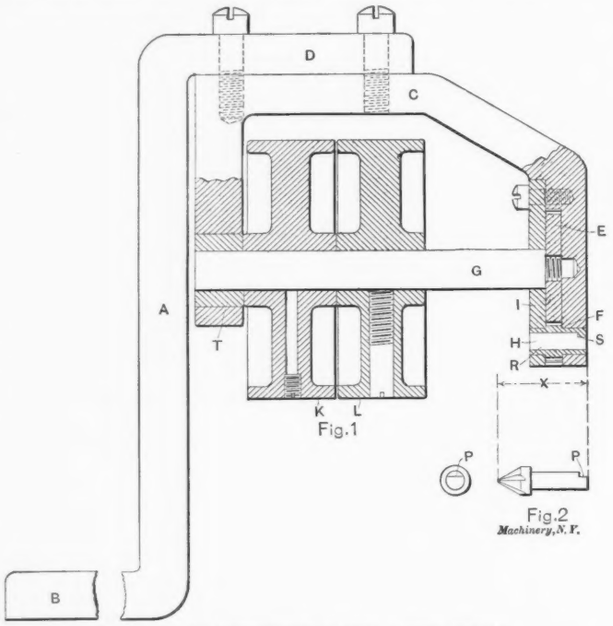
ROY PLAISTED.

Hartford, Conn.

DEVICE FOR COUNTERSINKING HUBS OF WIRE WHEELS.

The spoke-holes in the hubs of wire wheels usually have to be countersunk, and the accompanying cut illustrates a device for countersinking such spoke-holes on the insides of the flanges of the hubs. In the cut, Fig. 1 is a side elevation, partly in section, of the countersinking device, and Fig. 2 shows in detail the countersink used with it.

The device is usually secured to a bench or stand. The frame consists of a Z-shaped bar *A*, bolted to the bench by bolts through the projecting end *B*. A yoke *C* is secured to the upper projection *D*. The outer part of the yoke *C* is counterbored with recesses for the gears *E* and *F*, and contains bearings for one end of the shaft *G* and for the pinion sleeve *H*. A plate *I* is screwed on to keep the gears in place, and provides additional bearing surface for the shaft and sleeve. The



Device for Countersinking Hubs of Wire Wheels.

inner portion of *C* has a bushing *T* which forms a bearing for the inboard end of the shaft *G*, and can be readily removed so as to have a hole with plenty of clearance when assembling the shaft with the pulleys *K* and *L* and the gear *E*. This latter gear is fastened by screwing it onto the reduced portion of the shaft, which is threaded right hand, and, as the shaft turns clockwise, as viewed from the left, continued turning tends to force the gear more tightly on the shaft. Fig. 2 shows the countersink adapted for use in the machine, and it will be noticed that the countersink is of the usual type, but has a flatted portion *P* at the rear end of the stem. The hole *R* in the sleeve *H* fits the countersink, and drives it by the flat *S* fitting against the flat *P* of the countersink.

This type of device has been made small enough to countersink holes in articles where the working space or distance *X* is 5-16 inch, that being the distance between the barrel and the undercut flange of the hub of the wire wheel.

Brooklyn, N. Y. C. D. KING.

STANDARD LATHE SPINDLES.

There is one thing that has caused the average machinist as much profanity as anything that I know, and that is the lack of standard size and pitch for the threads on lathe spindles. Time and again jobs have come up that could be done on some idle lathe, if only the chuck or face-plate of some other lathe could be used. Of course, I know as well as anyone, that where extreme accuracy is needed, it would not do to use a face-plate not fitted to the machine, but there are hundreds of jobs that come up every year, where it would be a great convenience if the threads on the spindles on lathes of the same class were the same size and pitch.

Why cannot the lathe manufacturers get together on this subject and end the conglomeration of sizes and threads on what is just as easy to make alike? What a satisfaction to the small shop man to know that if he could not do a job on his 12-inch Lodge & Shipley lathe, with a three-jawed chuck, he had a four-jawed chuck on the shelf under his 12-inch Barnes'; this would be just the thing. The centers, too, should be the same. What sense is there in the lathe over in the corner taking a No. 3 Morse taper shank in the tail-stock, while the same class lathe next to it takes a No. 1 or a No. 2?

How few shops have, or can afford to have, a complete outfit for each lathe, and what a tremendous amount of time is lost in the aggregate all over the country by men running from the machine to the tool-room, exchanging drill chucks and sockets in their endeavor to get something to fit an odd-sized hole in the tail-stock spindle, and this, too, on lathes that have been made in the last year or two? Another annoying thing is for a man to work on a lathe, where the tail-stock screws in by turning the handle to the left, when he has been used to one which screwed in by turning to the right, as it naturally should. Apparently, the only reason for making a tail-stock so that it tightens by turning the handle to the left is that a few manufacturers think it is easier to make a right-hand screw, or else they do it to be different. If anyone ever heard of a really good reason for it, I'd like to hear it, as in fourteen years in various shops, I have never heard a valid one. ETHAN VIALL.

Decatur, Ill.

TOOLS FOR MAKING ARMATURE LAMINATIONS.

The cuts, Figs. 1, 2, 3, and 4, illustrate the method of producing the armature lamination, Fig. 5, of a motor, during the experimental and, later on, the manufacturing stage. In the first case the cost of tools is considered, and in the second, the manufacturing cost. In Fig. 1, *A* is a die holder for holding round dies. These holders were made for holding ordi-

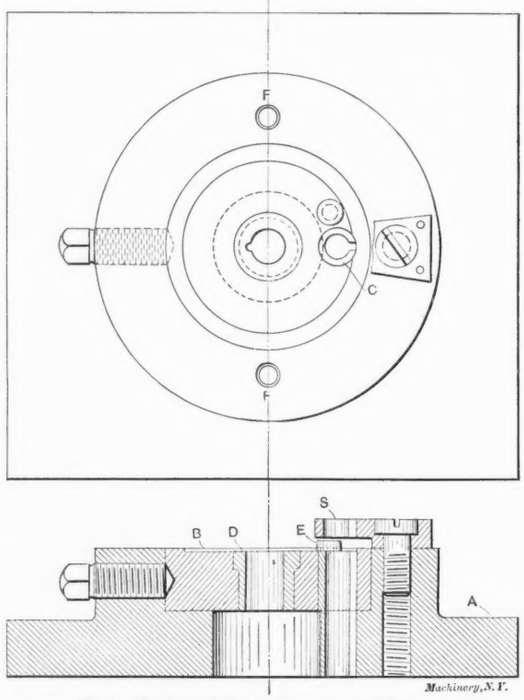


Fig. 1. Tool used during Experimental Stage.

nary blanking dies, and instead of fastening the stripper to the die, it is fastened to the bolster or holder. The first operation is punching the blank; the second is the punching of the slots. This is done with the die, Fig. 1. The pilot or index pin *E* is removed, and one slot is punched in the blank. After this operation is completed, the pin is replaced and the rest of the slots are punched, the pilot or index pin being located so as to index correctly. The die holder *B* is made from machine steel and recessed to allow the blank to fit properly; the die proper, *C*, is sweated fast in its place so as to avoid any chance of shifting its position. The die *D* is

used for the last operation, the punching of the center hole for the shaft. The stripper *S* is removed when punching this hole, and another is placed at *F F*. This latter is, of course, removed when punching the slots. The pilot pin *E* is used in the last operation also for locating the keyway properly in the blank. The cost of these punches and dies was small, but the manufacturing cost would come high if used to produce large quantities.

As enough of laminations were wanted to warrant a more expensive punch and die, and the manufacturing had to be cheapened, the design shown in Figs. 2 and 3 was adopted. These cuts need no further explanation as to the operation of the tool. It is readily seen that a complete lamination is obtained at each stroke of the press. A special milling cutter was made to mill the punches. Fig. 4 illustrates the method of milling the punches as well as the broach for sizing the holes in the die. First both sides are milled as shown at *x'*, leaving a key at both sides of the punch or broach. Then one of the keys is milled off as shown at *x*. A small section is inserted at the center hole of the die, leaving a solid key in each blank instead of the keyway in the experimental lamination shown in Fig. 5. A. C. L.

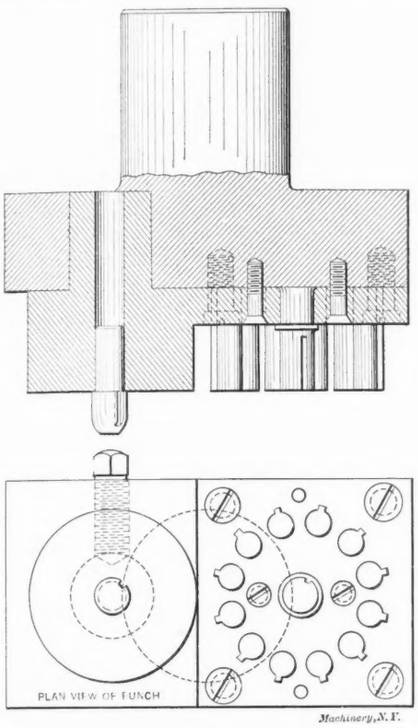


Fig. 2. Punch for Manufacturing Laminations.

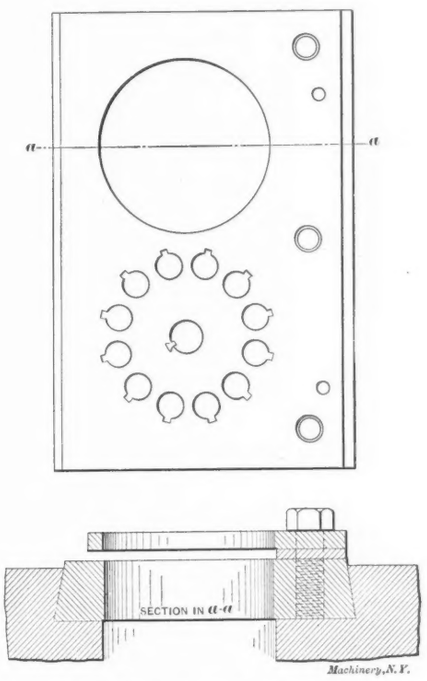


Fig. 3. Die used with Punch in Fig. 2.

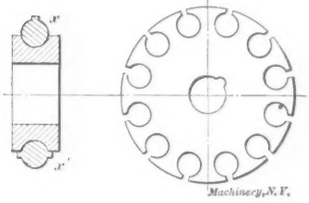


Fig. 4. Fig. 5.

INDUSTRIAL LIFE INSURANCE AND THE WORKMAN.

I rode in the cars the other day with a harmless-looking young fellow, whom I found to be very different from his looks, and against whom I want to warn your readers. He proved to be a life insurance agent. Now, to me, a life insurance agent is a man who ought to be shot at sight, but that is only a personal opinion and not one that I expect to see followed out. This particular chap sells or places industrial insurance. The way I happened to find it out was because after we had begun to talk he owned to his line of goods and I asked him why he had not tried to solicit me. He said: "I thought by the looks of your hands that you couldn't earn your living at a trade." His prey is the horny-handed workingman. Since the majority of your readers come under that classification, they undoubtedly know what industrial insurance means; all the more because in Massachusetts alone at this time, over a thousand of these policies are being issued every working day. If there are any who do not know, I will say that this form of insurance is ordinary life insurance in homeopathic doses, with premiums so small as to be "easy" to pay, and coming so often as to amount to practically double the rates that employers and others pay. Men who work within walls, whether blacksmiths, machinists, school teachers or molders, are known to be particularly prone to spend money foolishly. Knowing this, the industrial insurance men say they see no reason why they should not bid for it, and bid they do, and successfully. This agent gave me some figures from a report of the Massachusetts Insurance Commission showing that at the end of 1905 there were over a million of these policies in force in that state and nearly seventeen millions in the whole country.

Since I grant that life insurance is a desirable thing in any family, wherein is this friend of mine harmful? The trouble is right here, to cite freely from this same report. In the last fifteen years these companies have collected, in Massachusetts alone, $61,000,000. They have paid back in death claims, etc., only $21,000,000, and have left in their treasuries available for the settling of claims only $10,000,000. The other $30,000,000 are gone. Add to this the interest which this money would have accumulated at savings bank rates, and it amounts to the tidy sum of $49,000,000 transferred from the pockets of wage earners to the pockets of stockholders and agents, for that is where most of it has gone. Nobody has greater need of good life insurance than the man whose income is at best but little more than his needful expenses, and no one needs it more at a low cost. Now, the real cost of life insurance is a certain thing. Life insurance is a scheme by which a large number of persons pool their savings during their lives, and the family of each member of the pool draws out that member's share when he dies. Since a certain percentage of all the people die at certain ages, it is comparatively simple to compute each dying member's share, if it is known beforehand what interest can be obtained on the money which is in the pool. If these pools were purely voluntary, that is, if they were formed by the men concerned, themselves, and managed by themselves without their receiving salaries, then the cost of insurance would be low, very low, even as compared with the rates charged on large policies, and if the money in the pool were placed where it was safe at low rates of interest, it would be good life insurance. But a man or men who conduct such a pool want all there is in it for themselves, so they charge a high rate for their services. Then, again, men do not form these pools voluntarily, so agents have to be paid to bring them in. The result is that life insurance costs the insured all that the traffic will bear, which means more to the workingman than to anyone else, just because he is not well enough posted to see that he is being mulcted. A man insured by an industrial company pays about twice what a man in a good mutual or stock company pays on a thousand-dollar policy, and he, in turn, pays nearly twice the actual cost of his insurance. In these industrial companies the expense of conducting the business is about 40 per cent of the money handled, while the savings banks do their work on 1½ per cent of the money they handle, including taxes, which the insurance people usually manage to avoid. After seeing how badly off the work-

ingman who takes out this form of insurance is, if everything goes well, notice that in one-third of all cases the policies are allowed to lapse within three months and, in two-thirds within three years. These men simply pay and lose it all.

Then, again, the comparison is even less favorable to the workingman, because most of these companies do not pay the full face of the policy if death occurs before a certain time elapses, and as a good part of the policies are allowed to lapse before that time, it will appear that the large majority of the policies issued are either never settled at all or else settled at a discount from their face value. As an illustration, the Massachusetts report cites the fact that in 1905 the Columbian National Life Insurance Co. paid only 699 policies, either in full or in part, while 79,677 policies lapsed. Now, what does the lapsing of a policy mean? To the uninitiated it would seem to mean that the company got some money very easily, as the policy-holder never sees it again. But the company says no, as it takes three years or more to collect money enough to pay the expense of starting the policy. They pay the agent ten or twenty premiums commission when he gets the first one, so they must naturally lose on most of these lapsed premiums, and yet they all find their stock quoted way above par. My friend of the car put a new light on this point. He said: "They pay us a good commission, that is true, and they pay us a commission for collecting every premium, but we have to be responsible for the premiums on the policies that we solicit. That is, if you take out a policy with me and you carry it along for three or four months I get $2 for soliciting it, if it is a ten-cents-a-week policy, and I get two cents a week for collecting, but if at the end of three or four months you stop paying, then I have to pay it or drop my job; that is, I am eight cents a week out till the company has got back all the actual, and some imaginary, cost of getting your policy." By this means the companies appear to pay good commission, and yet really they protect themselves by shifting the responsibility for collections on their agents. To the agent the all-important thing is to get new business. If he is carrying my policy along at a loss of eight cents a week, if he can solicit Tom or Dick for a ten-cent policy, he makes his $2 on the spot and he uses it to carry my policy along for twenty-five weeks.

Then look at the way these policies are solicited. You are struggling along, never really getting much ahead. You have a wife and babies. The agent comes to see you; he gets you to get your wife in the room, which is *your* fatal mistake. Then he begins to draw pictures of your poor wife and children left without even the money to bury you with, cast adrift, furniture sold to pay the rent, and all the time your wife is thinking about your telling her of the chap that was caught on a shaft a few days ago and whirled around and picked up for dead or worse. Before he leaves, you have taken a policy that will cost you a dollar a week. Before long you begin to feel that you must let one week go by; there is the new suit of clothes, and the piano, and the kitchen stove, and any number of other things all drawing a dollar a week. These other things are tangible; if you don't pay the installments, the furniture van will back up, but when your policy lapses you don't perceive any change in your condition. What you have lost is intangible, and you can renew it later. But every time you renew, your policy is a little less in value for the same premium, so part of your money is gone, anyway. "What would I suggest?" Why, take out a policy just as your employer would. Make it a thousand dollars; it won't cost you any more than five or six hundred will with the industrials. Pay your premium quarterly if you want; it won't be more than six or seven dollars at a time. Give your wife half a dollar every pay day and let her keep the policy and keep it up. She is the interested party and she will do it. Women may have a weakness for millinery, but they don't travel past nearly so many grog shops every day as you do, and most of them have a better eye to the future than men have. If you cannot afford even this, take out a term policy; this is one that runs only for a limited time, say seven or ten years. The rates are much lower, but be sure you get what is known as a "convertible" term policy, so that at the end of the term you may take out a new policy, in any form which you may wish, without a new examination. CON WISE.

CONVERSION OF AN OLD PLANER INTO A MILLING MACHINE.

The cuts, Figs. 1 and 2, show an old obsolete planer which, having been in operation for twenty-four years, was recently converted into a milling machine through the application of a No. 2 Farwell milling attachment. I have frequently seen

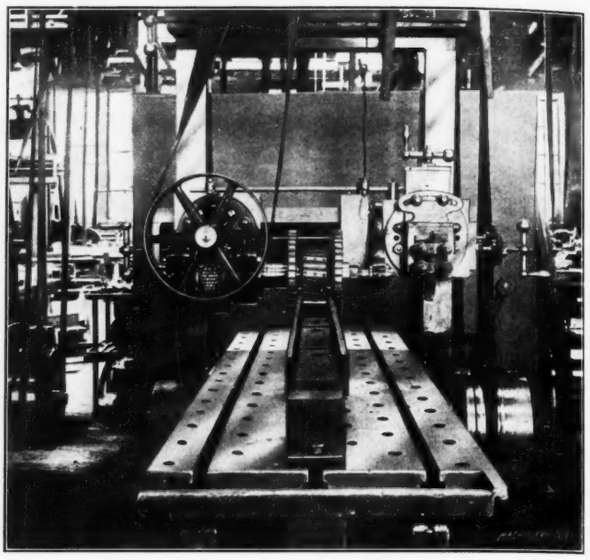


Fig. 1. Old Planer Converted into Milling Machine.

heavy slab milling machines at work milling the two outsides of locomotive shoes and wedges, but by merely drilling a countersunk hole in each shoe and fastening a number of them to a suitable jig, as shown in Fig. 2, several of them can be milled on the inside and outside at the same time. By using this milling attachment on the planer we can do as many in four hours as we formerly did on the planer itself in nine hours. It takes, on an average, one hour to grind the cutters in every twenty hours of service. Before grinding the

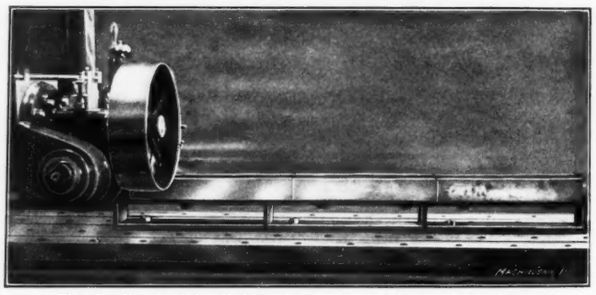


Fig. 2. Jig used for Holding a Number of Shoes and Wedges.

large end cutters, as soon as one side gets dull, I change them around on the arbor so that both sides get an opportunity to be at work before resharpening them. This way of finishing the shoes and wedges may not be original, but I have not as yet seen it done in this manner in any of the shops where I have been. M. H. W.

HOW JOHNNY SUCCEEDED IN GETTING AN INCREASE IN WAGES.

Johnny had been waiting for nearly a week to catch the boss when he was feeling good-natured to "strike him" for more pay. One morning the boss came around feeling in the best of spirits, and Johnny promptly took advantage of his opportunity. "Let's see, how many times have I given you a raise during the past year?"

"Twice," said Johnny.

"You are now receiving $2.50 per day; don't you think that is pretty good pay for a boy that has been 'out of his time' only a year?"

"No, sir; not when I notice that you pay green men $3.50 per day, and after they spoil the job you discharge them and turn the job over to me to make. If a new man is worth

$3.50 a day to spoil work, I surely must be worth $2.75 to satisfactorily complete the job."

"Those men you speak of hired out as first-class men; they lied to me and were promptly discharged, and I fail to see wherein their inefficiency has anything to do with your claim for more pay. What you need is more experience, and then more pay will be forthcoming."

Said Johnny: "My argument is, that it is not experience that counts so much as one's ability, for in this particular case these men have certainly worked at the business longer than I, but were unable to do the class of work that I am doing. For instance," continued Johnny, "suppose that the *very best* tool-maker in the United States should come along here and hire out for $2.50 per day claiming that he had not been at the business very long, how long would he be obliged to work here to receive $3.50 per day? How often would you raise him—every six months, as you do me?"

"If he was worth more money I should promptly give it to him."

"Well, cutting out this 'experience' part of it and talking from the standpoint of a man's worth, don't you think that I am worth $2.75 per day?"

"Well, I guess you are, Johnny. I'll start you next week at $2.75."

S. E. F.

THE POSITION OF THE CHECK NUT.

A mistake which is often made in machine design and building, and which sometimes can be found even in our best and most reliable engineering hand books, is to put the check nut used for the securing of an ordinary nut on the top, instead of at the bottom, of the regular nut. A little consideration in regard to the intensity and directions of the forces acting on the two nuts will very plainly show that the right place of the check nut is under the ordinary nut.

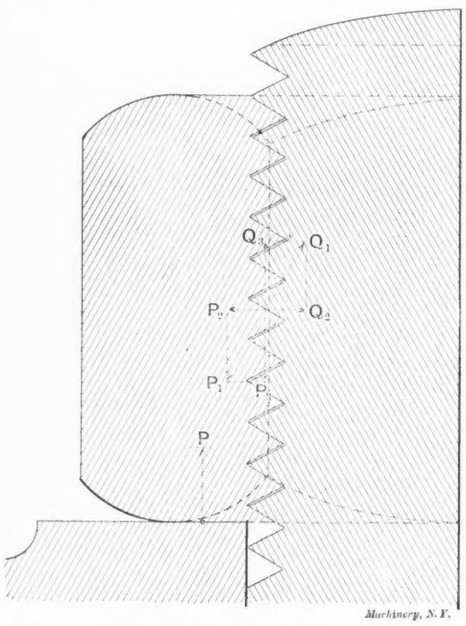


Fig. 1. Action of Forces, Single Nut.

In common practice the check nut is given a height equal to half the height of the ordinary nut, which latter commonly has a height equal to the diameter of the engaging bolt. Fig. 1 illustrates a case where only one nut is being used. Considering the forces, P is a force due to the tightness with which the nut has been screwed into place, and is acting on the lower surface of the nut, and directed upward. P_1 is a force due to same cause, acting from the threads of the screw on the threads of the nut, and directed downward, making a right angle with the surface of the thread. This force P_1 can be divided up into two components—one, P_3, directed downward, parallel with the center-line of the screw, and one P_2 at right angles to the same. The force P_3 is equal to and directly opposite P. Both are acting on the same piece, and they are, therefore, in equilibrium. The force P_2 is in equilibrium with the internal stresses in the nut. As will be seen in Fig. 1, only the upper surfaces of the threads of the nut are bearing against those of the screw, a slight play being left between the other thread surfaces. This play is due to the fact that neither the screw nor the nut ever can be made absolutely exact, and the play is, in fact, necessary in order to enable the nut to be screwed on.

The case where a check nut is used for the purpose of securing the ordinary nut is illustrated in Fig. 2. The forces acting on the upper nut will be equal, both in regard to intensity and direction, to those in the case of where only one nut is employed. Considering the lower nut, we have, acting on this, the force P, due to the pressure of the upper nut and directed downward, and the force p, due to the pressure

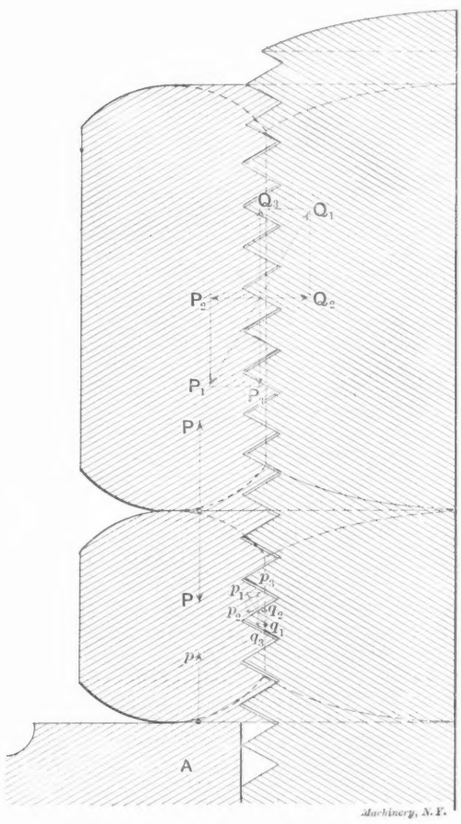


Fig. 2. Action of Forces, Check Nut Used.

from below, and directed upward. These two forces together give a resultant equal to $P - p$, directed downward, which is in equilibrium with the force p_3, the vertical component of the force p_1. This represents the pressure from the upper surface of the thread of the screw on the lower surface of the thread of the nut. The other forces shown in Fig. 2, their directions and relative relationships, can easily be seen from the diagrams.

It is plain that the pressure on the threads of the lower nut is directed upward. Therefore, the threads of the upper nut have to take the pressure from the body A, that is, all the pressure caused by tightening the nut, and, in addition, all the pressure on the threads of the lower nut. The pressure on the threads of the lower nut is very small compared with that of the upper nut, a fact which proves beyond doubt that the upper nut should be stronger than the lower one.

High Bridge, N. J. OSKAR KYLIN.

METHOD OF ANNEALING NOVO STEEL.

A great many times a machinist wants to use a piece of Novo steel for some special job, but, not having a piece that is soft enough to work, he uses carbon steel instead, generally because he does not know how to anneal high-speed steel, and imagines that an elaborate heating system must be used. I have met dozens of blacksmiths, tool-dressers, and machinists who declared that the thing was impossible, but who quickly changed front when showed how. Not long ago, a writer in

one of the prominent mechanical journals, who said he had done nothing but worked with steel all his life, described his process for annealing Novo steel. He packed it in a tube or iron box in ashes, clay or charcoal, put it in the furnace, and kept it at 800 degrees F. for five hours, then at 900 degrees F. for seven hours, and then he let the fire go out, and removed his steel from the furnace twelve hours later.

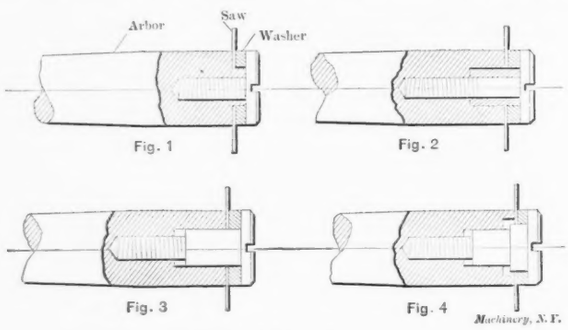
This method seems rather inconvenient, however, and the writer would propose the following: If you have a piece of Novo steel that you want to soften so that you can drill, file or tap it, get a barrel of old slacked lime and a piece of pipe, threaded on both ends. Get a pipe large enough to allow the steel plenty of room. Put a cap on one end and put in about an inch of lime at the bottom, drop in the steel and pack lime around it, keeping the steel in the middle of the pipe, and fill the other cap with lime and screw on. It will be well to explain here that the whole secret of annealing this or any other steel is to keep it from coming in contact with the air and thereby chilling while in the process of cooling.

Next put the pipe and contents into the fire, and heat slowly and evenly to a white heat, then take out the pipe and bury it quickly in the middle of your barrel of lime and leave it twelve or fourteen hours. For ordinary sized pieces the time taken to heat will not be over twenty minutes, and if you have a good-sized forge it will be considerably less. Be sure the steel is heated through before taking it from the fire. I have annealed hundreds of small pieces of Novo steel in this way, and have never yet met with a failure. E. VIALL.

Decatur, Ill.

SOME TYPES OF SAW ARBORS.

In manufacturing, as well as in the ordinary machine shop, the types of saw arbors shown in the cut are used to a great extent on account of the small space required outside of the saw, a screw being used in place of the regular nut. The question has come up a number of times as to which of the designs shown in the sketch is the best. The sketch shows four of the common designs, and the writer has seen preference given to different ones by different shops, and would like to have the opinion of the readers of MACHINERY as to which is the best design.



Types of Saw Arbors.

Fig. 1 shows the old, common, soft arbor, which still holds its own in many places. Fig. 2 shows one that will bear consideration, the hard bushing giving it an advantage over the one in Fig. 1. This arbor is also soft and can be trued up at any time. This is another good point in its favor. The arbor shown in Fig. 3 was a favorite with an old boss of mine, and he had many reasons, the principal one being that the arbor could be used for a thicker saw without extra washers and still hold its principle, that of having the saw at the extreme end of the arbor. This is the only advantage I can see over the one in Fig. 2. The arbor in Fig. 4 is of the same general type as the one in Fig. 3, but has an additional advantage; the arbor can be used with a saw of another size hole by simply changing the screw. ARTEBE.

SIMPLE SOLUTION OF HOPPER PROBLEM.

In the "How and Why" columns of the May issue of MACHINERY formulas were given for computing the angle between the slope sheets of a hopper, the pitch of the sides being known. These formulas are unhandy for use and, as a much more simple expression can be obtained without the use of more complex mathematics, I suggest the following:

$A\ H$ and $A\ K$ are slope sheets of a rectangular hopper and intersect in $A\ B$. $B\ G$ is a perpendicular to $E\ A\ F$, the plane of the top of the hopper. $C\ B$ and $D\ B$ are respectively perpendicular to the edges $A\ E$ and $A\ F$.

$\angle\ G\ B\ C = \alpha$ and $\angle\ G\ B\ D = \beta$, α and β being the angles which the sides make with the vertical. $E\ B$ and $F\ B$ are each perpendicular to $A\ B$, hence $\angle\ E\ B\ F$ is the angle between the sides $A\ H$ and $A\ K$.

According to principles of elementary trigonometry,

$$\cos E\ B\ F = \frac{\overline{E\ B}^2 + \overline{F\ B}^2 - \overline{E\ F}^2}{2\ E\ B \times F\ B} \qquad (1)$$

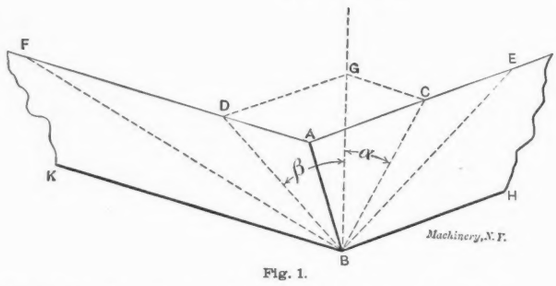


Fig. 1.

But since $E\ A\ F$, $A\ B\ E$ and $A\ B\ F$ are right angles

$$\overline{E\ F}^2 = \overline{E\ A}^2 + \overline{F\ A}^2$$

and

$$\overline{E\ B}^2 + \overline{F\ B}^2 - \overline{E\ F}^2 = \overline{E\ B}^2 - \overline{E\ A}^2 + \overline{F\ B}^2 - \overline{F\ A}^2 = -2\ \overline{A\ B}^2 \qquad (2)$$

In the right triangle $E\ B\ A$

$$E\ B = A\ B \tan E\ A\ B.$$

We can see that

$$\tan E\ A\ B = \tan C\ A\ B = \frac{C\ B}{A\ C} = \frac{C\ B}{D\ G} = \frac{B\ G \sec \alpha}{B\ G \tan \beta}$$

$$\text{hence } E\ B = A\ B \times \frac{\sec \alpha}{\tan \beta} \qquad (3)$$

$$\text{and similarly } F\ B = A\ B \times \frac{\sec \beta}{\tan \alpha} \qquad (4)$$

From (1), (2), (3) and (4) we easily get

$$\cos E\ B\ F = -\frac{\tan \alpha \tan \beta}{\sec \alpha \sec \beta} = -\sin \alpha \sin \beta \qquad (5)$$

In the usual construction of hoppers, each side will slope outward, sin α and sin β will have like signs and cos $E\ B\ F$ will be negative, indicating that the angle is greater than a right angle.

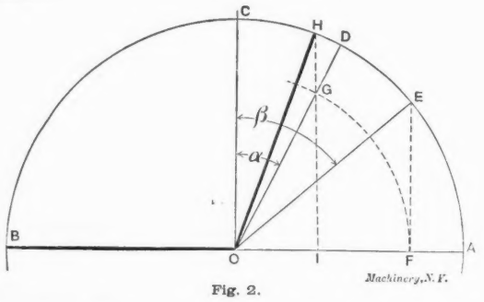


Fig. 2.

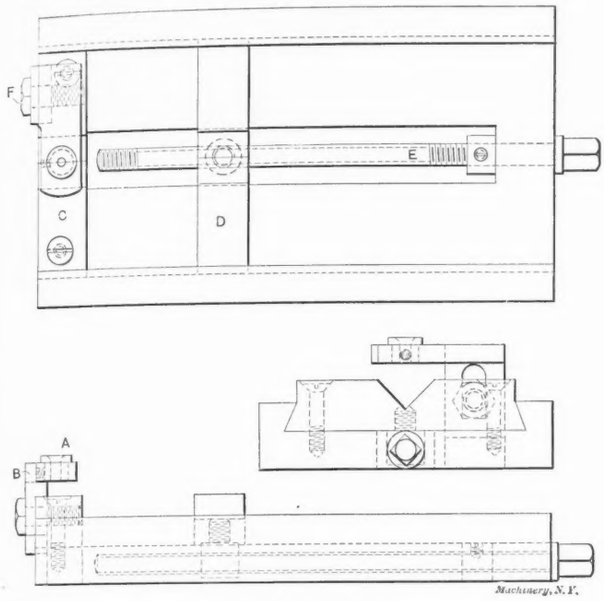
To illustrate the use of formula (5) let $\alpha = 27$ degrees and $\beta = 50$ degrees.

Then—sin α sin β = —sin 27 degrees × sin 50 degrees = —0.4540 × 0.7660 = —0.3478, the cosine of 110 degrees 21 minutes. The required angle is, therefore, 110 degrees 21 minutes. The result may be obtained very easily by the following graphical method:

In Fig. 2 the semicircle $B\ C\ A$ may be drawn to any radius. $C\ O$ is perpendicular to the diameter $B\ A$. Make $\angle\ D\ O\ C = \alpha$, and $\angle\ E\ O\ C = \beta$. Project E to F on $A\ B$. With radius $O\ F$ describe an arc about O, cutting $O\ D$ in G. Project G to H on semicircle. Join H and O; then $H\ O\ B$ is the angle required. M. D. G.

PIN HOLE DRILLING JIG.

The cut herewith shows a jig for drilling pin holes in studs. This device will handle a variety of such work with great rapidity. The drill bushing *A* can be removed and bushings with different size holes inserted. The bushing holder *B* can be raised or lowered to suit different diameters of work. The V block *C* is fixed, while block *D* is adjustable by means of the screw *E* for different lengths of studs. By fastening a



Pin Hole Drilling Jig.

strap to the device by screw *F*, and providing this strap with an adjusting screw in line with the V's, studs can be gaged from the end instead of from the shoulder. The manner in which this jig is used lends itself well to a variety of work of all descriptions.

PAUL W. ABBOTT.

Lowell, Mass.

BLUE-PRINT RECORD CARD.

A firm whose line of work is such that improvements and changes of designs and details are constantly being made, as is the case in the automobile business of to-day, must by necessity devise some system of properly keeping track of the blue-prints in the factory. In an establishment where there are several hundred prints in twenty to twenty-five different departments, it is very necessary that there be some good sys-

DRAWER NO. 27 — NAME: CRANK SHAFT — TYPE BLUE PRINT NO. G4 5681

DELIVERED	DEP'T	CONDITION	CHANGED	CHANGED	CHANGED	CHANGED	RETURNED	REMARKS
3/20 '07	PUNCH	UNMOUNTED DROP FORGE		X	X			
3/20 '07	PUNCH	UNMOUNTED DROP FORGE	NOT REQ'D	NOT REQ'D	NOT REQ'D			FOR ESTIMATE 2 PUNCH FIXTURES AND 1 OUTSIDE
3/25 '07	EXPER.	UNMOUNTED MACHINE	4/3 '07	NOT REQ'D	NOT REQ'D			
4/3 '07	PUNCH	UNMOUNTED DROP FORGE	5/4 '07	NOT REQ'D				ORD. D.F. DIES
5/ '07		MOUNTED MACHINE	5/4 '07	5/20 '07				
5/1 '07	12	MOUNTED MACHINE	5/4 '07	5/20 '07				
5/3 '07	16	MOUNTED MACHINE	5/4 '07	5/20 '07				
5/18 '07	20	MOUNTED MACHINE		5/20 '07				

Blue-print Record Card.

tem of keeping in touch with every blue-print, in order that the proper ones may be corrected when a change is made.

The card shown in the cut is one devised by myself, and used to great advantage by The Garford Co., to keep track of all blue-prints issued from the drafting room. Each part of our machines is detailed on a separate standard sheet, and mounted on pressboard for the shop. Each department has also a complete book of blue-prints for each type of automobile. When a change is made on a drawing, a new blue-print is made to supersede each blue-print in the factory. On issuing a blue-print from the drafting room, a card like the one here shown is filled out. The name of the piece is entered in the place marked "Name." Blue-print number and drawer number (which is the drawer where the tracing is filed) are placed on with a stamp in their proper places. In the column marked "Delivered" the date is entered, and the department number placed in the column marked "Dep't." Under the heading "Condition," the mounting and kind of the blue-print is noted, either mounted or unmounted, machine, drop-forge or pattern drawing. For this, a rubber stamp is used. When a change is made in the tracing, by looking on the proper card, it is readily seen where the blue-prints are, and which ones are to be changed. In the columns "Changed," the date when the new blue-print is delivered and the old one is returned, is noted. If for any reason it is not necessary to change the blue-print in some departments, a check or some other mark is placed in the space instead of the date, and a similar check or mark placed on the back, and the reason noted. If, for instance, the piece was a casting and some drilled hole is changed from one-quarter inch to three-eighths inch, it would not be necessary to change the blue-print in the pattern shop. Each department has its own blue-prints and they are never delivered from one department to another without first going through the drawing room. When the department is through with the blue-print, it is returned to the drawing room, and the date entered in the column marked "Returned." The above system works to good advantage, and may be of value to others.

A. B. HOWK.

Elyria, O.

GRINDING GEAR-CUTTER TEETH TO LENGTH.

Referring to the July issue of MACHINERY, I note the article "Importance of Grinding Gear-Cutter Teeth Radially." I am a little surprised that the same article did not call attention to another feature which is as important as the one brought forth, being that when the teeth are ground back from the base, all teeth should be ground an equal distance. Otherwise, those teeth which are ground the least will have to do all the cutting.

F. H. STILLMAN,
Watson, Stillman Co.

New York.

[A simple method that is commonly used in grinding cutters to insure that all the teeth shall do an equal share of the work is to grind only those teeth that are most dulled on the points. These are the teeth that have been doing the greatest amount of work, and should be sharpened more than those that are not dulled. After careless grinding it will be found that some teeth have done little or no work at all. These teeth, of course, should not be touched in regrinding. In this manner the requirement mentioned by Mr. Stillman may be very easily met in grinding gear cutters.—EDITOR.]

* * *

Two of the most notable and, perhaps, the handsomest sky-scraper structures in lower New York are the Trinity Building with its new annex and the Realty Building adjoining, both being of the same Gothic style of architecture. The Trinity Building was built three years ago on a very narrow plot of ground adjoining Trinity churchyard, and its general style is in keeping with the venerable Trinity Church. Then an adjoining plot of ground, north, was acquired, and the location of the narrow Thames St. was shifted northward a short distance to permit of the building of an annex to the Trinity Building. This change reduced the size of the Realty Building lot to approximately the same width, so that both buildings are of about the same size. The Trinity Annex and the Realty Building were erected in record time. The first steel columns were set September 15, 1906, and both structures were opened May 1. Both structures are 21 stories high, and they represent a total investment of about $15,000,000. Perhaps there is no spot in New York where the impressiveness of these great modern office structures of lower New York can be realized so well as on Trinity Place, looking up through the narrow canyon-like streets separating the new buildings and the adjacent buildings on the north.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

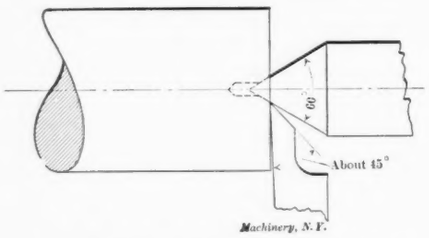
TO SHARPEN LEAD PENCILS.

The rotary pencil sharpeners are a boon to the pencil manufacturers, especially where hard pencils are used. The pencil supply in a certain drafting room, which was usually ordered every six months, was exhausted in less than four months since one of the standard ordinary pencil sharpeners had been installed. The best and quickest method for pointing a pencil is to lay a half-inch carpenter's chisel down on the drawing board with the bevel on the lower side and the edge away from the body. Then draw the pencil across the edge of the chisel toward the body and at an angle of about 15 degrees to the board. The results obtained are very satisfactory. E. A. PRITCHARD.

Champaign, Ill.

FACING WORK ON CENTERS.

The common method of facing work between lathe centers consists in slightly unscrewing the tail-spindle to allow the side tool to approach the center of the work. This is a very bungling method, and often causes botched work; but it must be quite general, for the writer has known it to be used in

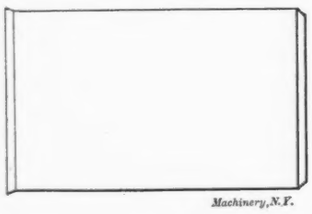


different sections of the United States, and it is given as the proper method in one of the most progressive works on shop practice. A better way is illustrated herewith. It will, of course, be understood that the object of unscrewing the tail-spindle is to allow the point of the tool to cut away the slight tit or ridge that is sometimes left at the center of a shaft; but if the side tool be ground to about 45 degrees, as shown in the cut, there will be no trouble in facing the end of the work quite flat, without slackening the tail-spindle. As an instructor in shop practice, the writer has always followed the method here advocated. W. S. LEONARD.

Atlanta, Ga.

DRIFT FOR BABBITTED BOX.

Did you ever have a "hurry up" job babbitting a solid box, and have to spend three-quarters of the time scraping the box out for a running fit? One way to overcome this is to take a short piece of shafting, and with a light hammer upset one end so that it becomes about one-hundredth of an inch larger in diameter. File or grind the sharp corner from the other end. This makes a handy drift which can be driven through the babbitted box, expanding the babbitt tight in position, and making an easy running fit for the shaft. STANLEY GOULD.

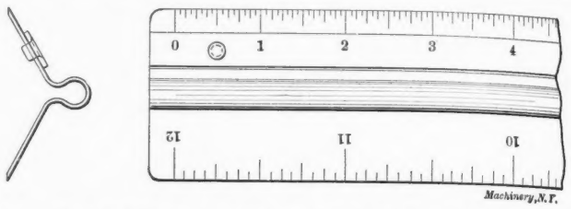


Los Angeles, Cal.

ATTACHMENT FOR DRAFTSMAN'S SCALE.

The cut herewith shows a very simple means of converting the ordinary draftsman's scale, graduated to 1-16 and 1-32 inch, as manufactured by Brown & Sharpe Mfg. Co., into a scale that can be used for scaling or making drawings half size. The attachment consists of a narrow brass or steel strip with four or more pins inserted and riveted to it. These pins fit into holes which are drilled in the scale. A still better construction could be obtained by forming heads on the rivets, and having button-hole slots in the scale. If it is desired to adopt the scale for half-size work, number each ½ inch consecutively as full inches. For quarter size, each ¼ inch should be consecutively numbered with whole numbers.

Applied as shown, on the 1-32 inch side each graduation reads as 1-16 inch. The appliance shown serves the purpose nicely, but it is rather unfortunate that, in the present day of advancement one is obliged to contrive a makeshift. There

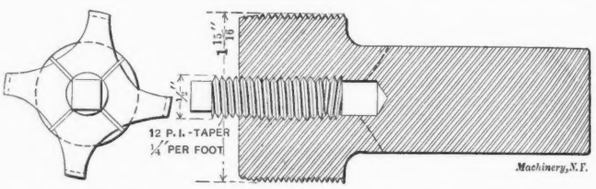


is no doubt but what scales of the design shown, graduated ¼, ½ and ¾ inch to the inch, would find a sale equal to the full size scale. WINAMAC.

[The B. & S. scale mentioned is made in a variety of graduations up to and including 3 inches = 1 foot.—EDITOR.]

INEXPENSIVE EXPANSION TAP.

The expansion tap shown in the accompanying cut may not be new to some of the readers of MACHINERY, but it is one which gives the best of satisfaction. It is intended for the turret lathe, the shank fitting in the hole of the turret. It is expanded by means of a taper screw having a taper of ¼ inch per foot. The screw shown in the cut is provided with a square head, but all screws smaller than ½ inch are slotted for a screw driver. The holes in the tap are tapped straight with ordinary plug hand taps. With the screws tapered and the holes straight, it is evident that the bearing is at the outer end all the time, and the tap is expanded by screwing in the screw. It will be noticed that the flutes are not milled



as deep as in a regular tap of the same size. The smallest expansion tap that we have as yet made on this principle is 9/16, 24 threads per inch. These taps have been in use long enough to prove that they are better than ordinary taps when one has to keep the threaded holes within limits of 0.001 inch. C. L. VANERSTROM.

Detroit, Mich.

HOW TO CLEAN YOUR HANDS.

Here is something that everybody does not know about. A tinner told me about it after I had nearly rubbed the skin off, a good many times, trying to remove soldering acid from my hands. Have a package of "Pearline" handy, and, by using a small amount, all traces of acid can be very easily removed, leaving the skin soft and clean. It will clean dirty, greasy hands when nearly everything else fails. It is great for printers, as it removes ink with great ease. Have a nail brush handy, and you can, in a few minutes, put your hands in shape to attend a card party, even after the dirtiest kind of a job. X. Y. Z.

* * *

In a reply to a correspondent who asks if it is advisable to use soft metal punches in connection with hard dies in press working of brass to produce ornamental designs, *Copper and Brass* states that soft punches are used extensively in drop presses for this purpose. They are cast directly in the dies, the best mixture being an alloy of 2 parts lead and 1 part tin. The punch retains its shape under a quick powerful blow by reason of the momentum of the particles, each of which tends to force the sheet metal ahead of it so as to perfectly fill the die.

SHOP RECEIPTS AND FORMULAS.

A DEPARTMENT FOR USEFUL MIXTURES.

This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.

With this issue the department of shop receipts and formulas is discontinued as a regular monthly feature. During the past two years nearly 400 receipts have been printed, many of them old and well-known, and others never before made public. That the department has been a popular and valuable one we are well assured by the many commendatory letters received and by the demand for the little booklet containing reprints of 150 of the most used receipts. This booklet will be revised soon and doubled in size.—EDITOR.

375. SILICATE OF SODA CEMENT FOR GRINDER DISKS.

We use silicate of soda (liquid glass) for fastening emery disks to a disk grinder, and think it is the best cement we ever tried. It requires no haste in applying, and the hotter the disk gets, the tighter it sticks. H. G. HERRICK.

Syracuse, N. Y.

376. TO CUT OFF GLASS TUBES.

Saturate a cotton string in kerosene, wrap it around the glass tube where you wish to have it cut, set fire to the string, and when all parts are ablaze, plunge the glass in a pail of water. Give the top of the glass a light blow with a stick, and there will be an even break all around.

Detroit, Mich. CHARLES SHERMAN.

377. TO GLUE ASBESTOS OR OTHER FABRIC TO IRON.

One of the most reliable cements or glues to use for attaching asbestos or any other fabric to iron is silicate of soda. It is successfully used for attaching emery paper disks to disk grinders. It is particularly useful for attaching asbestos to furnace pipes, because it stands heat well, and for this reason silicate of soda is an all-around cement of much value.

M. E. CANEK.

378. TO JAPAN CASTINGS.

Clean the castings well and paint them with pure boiled linseed oil. When the oil has dried, bake the castings in an oven at such a temperature as will turn the linseed oil black, japanning, and then the glossy black surface will show to good results the castings should be carefully smoothed off before japanning and then the glossy black surface will show to good advantage. A better mixture is asphaltum, 1 ounce; boiled linseed oil, 1 quart; and burnt umber, 2 ounces, thinned with turpentine. M. E. CANEK.

379. SILVER SOLDER FOR BRAZING.

Much difficulty arises in the use of brazing solder. The best alloy to use in brazing is the common silver solder. It has the advantages of a low melting point and toughness, which are not found to such a high degree in common brazing brasses composed of copper and zinc. The melting point of silver being lower than that of copper, and as it does not oxidize when heated, it is admirably adapted for use in brazing solder. The proper mixture for the solder consists of two parts fine silver filings and one part fine brass, which latter consists of 2 parts copper and 1 part zinc. T. E. O'DONNELL.

Urbana, Ill.

380. SOLDERING PASTE.

By the requirements of the electrical trade in certain cases no acid soldering flux can be used. A flux that can be used on any kind of work is known as a soldering paste. For soldering copper wires and other electrical conductors the paste is unequaled, and is particularly adapted for work in which spattering and corrosion are objectionable. The mixture for soldering paste consists of certain proportions of grease and chloride of zinc. The grease commonly used is petrolatum or vaseline, which will give the paste the proper consistency. The proportions used are petrolatum or vaseline, 1 pound, and 1 fluid ounce saturated solution chloride of zinc.

Urbana, Ill. T. E. O'DONNELL.

381. SILVER SOLUTION FOR ELECTRO-PLATING.

Put together, into a glass, one ounce silver, made thin, and cut into strips, two ounces best nitric acid, and one-half ounce clean rain-water. If the solution does not begin to act at once, add a little more water, and continue to add a very little at a time until it does. In the event it starts off well, but stops, before the silver is fully dissolved, it generally may be started up again by adding a little more water. When the solution is entirely effected, add one quart of warm rain-water and a large tablespoonful of table salt. Shake well and let settle; then proceed to pour off and wash through other waters. When no longer acid to the taste, put in 1¼-ounce cyanuret potassa and a quart pure rain-water. After standing about twenty-four hours it will be ready for use.

St. Louis, Mo. SAMUEL STROBEL.

382. ENAMEL FOR IRON OR STEEL.

Make an enamel by mixing 2 ounces of burnt umber with 1 quart boiled linseed oil, heating, and then adding 1 ounce asphaltum. Keep hot until thoroughly mixed, and thin with a small quantity of turpentine. Have the surface of the parts to be enameled thoroughly cleaned, and apply the enamel with a camel's hair brush, and allow it to set. Then place in an oven and bake for 6 hours, at a temperature of 250 degrees F. When cool, rub down with steel wool, and then apply the finishing coat of the desired color, and allow to bake for 6 or 8 hours. Rub down, when cool, with a soft cloth, then varnish and bake again at 200 degrees F. The heating and cooling should be done gradually each time so as not to crack the enamel. Black enamel usually requires a higher degree of temperature than any other kind, or about 300 degrees F. T. E. O'DONNELL.

Urbana, Ill.

383. ACID DIP FOR BRONZE CASTINGS.

A very suitable and effective acid dip for bronze castings may be made up in the following manner. The constituents required are one gallon pale aqua fortis, one gallon oil vitriol, four quarts of water, eight ounces of rock salt. In mixing the acids add the vitriol to the aqua fortis, after which the water should be introduced, by pouring in very slowly into the acid solution. Water should never be poured into the acids, separately. When the water and acids have become thoroughly mixed, the salt may then be added. The solution becomes quite warm after mixing, which is a good time to add the salt, as the heated solution dissolves the salt readily. After mixing, the solution should stand from 10 to 12 hours before using. It is best to make a large quantity of the solution if much dipping is to be done. To secure the best results it is necessary that the solution be kept at as low a temperature as possible, hence it is advisable to place the receptacle in a tank of cold water, or what is better, place it in running water.

Urbana, Ill. T. E. O'DONNELL.

384. ZINC DUST CEMENT.

A putty prepared with zinc dust does not have the drawbacks of those prepared with white lead or red lead. The oil used is that known as wood oil; this oil is extracted from a tree which grows in China and Cochin-China, known as the oil tree or *Eloecocca Vernica*. This putty possesses the peculiar property of hardening under the action of a very moderate heat, such as that which exists in steam boilers. With linseed oil, the hardening takes place at a higher temperature, but it is not as thorough, and a partial oxidation takes place, and it is accompanied by the production of carbonic-dioxid. With wood oil, the hardening is entire and rapid, and a rearrangement of molecules takes place without any chemical change; the physical constitution alone appears to be modified. The hardening of zinc dust cement is quite different from that prepared with white or red lead, as the action of oxygen is not required. Heating to 150 degrees centigrade is sufficient to complete the action, and at 110 degrees it is completed in six hours. This cement will keep for an indefinite period after hardening. ALFRED LANG.

Pittsburg, Pa.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

OVERSIZE LIMITS OF TAPS.

Tap-maker. In the July issue of MACHINERY a table was given stating the limits of oversize in diameter of hand taps. Does this table refer to hand taps only, or should all kinds of taps be made according to the figures there given? Are the dimensions in the table derived from actual practice, or have they been merely estimated or figured from some arbitrary formula?

A.—The figures given in the table referred to, cover all ordinary hand taps and all taps which, while not generally termed hand taps, are used in the same or in a similar manner, as, for example, pulley taps, screw machine taps, boiler taps, etc. Other classes of taps are made as stated in the tables below.

TABLE I. LIMIT OF OVERSIZE IN DIAMETER OF MACHINE SCREW TAPS AFTER HARDENING.

Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.
$\frac{1}{16}$	0 00075	$\frac{5}{32}-\frac{3}{16}$	0.00125	$\frac{9}{32}-\frac{5}{16}$	0.002
$\frac{3}{32}-\frac{1}{8}$	0.001	$\frac{7}{32}-\frac{1}{4}$	0.0015	$\frac{11}{32}-\frac{7}{16}$	0.0025

Hobs and die taps are made to somewhat closer limits in regard to the excess diameter. The figures given in the table below should not be exceeded under any circumstances, as a hob, the error in lead of which is so great as to require a larger excess in diameter than given, should not pass inspection.

TABLE II. LIMIT OF OVERSIZE IN DIAMETER OF HOBS AND DIE TAPS, AFTER HARDENING.

Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.	Diameter of Tap, inches.	Limit of Oversize.
$\frac{1}{16}$	0.00025	$\frac{7}{8}$	0.002	$2\frac{3}{4}$	0.003
$\frac{1}{8}$	0.0005	1	0.00225	3	0.003
$\frac{1}{4}$	0.00075	$1\frac{1}{4}$	0.00225	$3\frac{1}{4}$	0.0035
$\frac{3}{8}$	0 001	$1\frac{1}{2}$	0.0025	$3\frac{1}{2}$	0 0035
$\frac{1}{2}$	0.00125	$1\frac{3}{4}$	0.0025	$3\frac{3}{4}$	0.004
$\frac{5}{8}$	0.0015	2	0.00275	4	0.004
$\frac{3}{4}$	0.00175	$2\frac{1}{4}$	0.00275	..	.....

Tapper taps, and machine taps for general purposes, are threaded oversize, before hardening, as follows:

TABLE III. LIMIT OF OVERSIZE OF TAPPER TAPS AND MACHINE TAPS, BEFORE HARDENING.

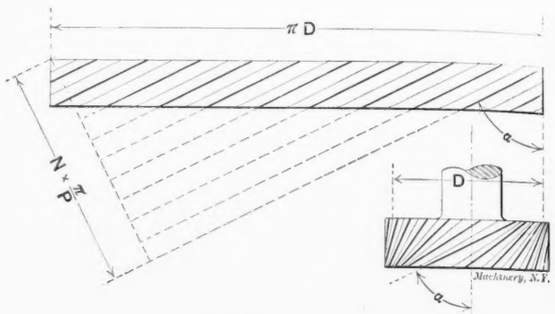
Diam. of Tap, ins.	Limits of Oversize.	Diam. of Tap, ins.	Limits of Oversize.	Diam. of Taps, ins.	Limits of Oversize.
$\frac{1}{4}$	0.0005—0.001	1	0.001 —0.002	$2\frac{1}{2}$	0.002 —0.003
$\frac{1}{2}$	0 001 —0.0015	$1\frac{1}{2}$	0.0015—0.0025	3	0.0025—0.0035
$\frac{3}{4}$	0.001 —0.0015	2	0.002 —0.003	..	.....

The figures given conform to the actual practice of one of our most prominent tap manufacturers.

SPIRAL GEAR DIMENSIONS.

F. S. L. Through the columns of MACHINERY, can you give me the calculations necessary for cutting two spiral gears of the following proportions; both gears to be 2-inch pitch diameter, 10 diametral pitch, which gives 20 teeth? The ratio is to be 2 to 1.

A.—You are mistaken in your belief that it is possible to have a spiral gear of 2-inch pitch diameter, with 20 teeth of 10 diametral pitch, if by the diametral pitch you mean the pitch of the cutter. Those requirements are all right for a spur gear, but the cutting of the tooth on an angle alters the matter, as you perhaps will understand from the cut. The spiral gear shown has a diameter D, and tooth angle a, with N teeth of P diametral pitch. The plan view above the drawing of the gear represents a development of its circumference at the pitch line. That is to say, it is as if the gear could be neatly pared with a sharp knife at the pitch line, and the resulting peeling straightened out as shown. The length of this peeling or development would evidently be the pitch circumference of the gear, which equals πD, in which, of course, $\pi = 3.1416$. In the development, the teeth have been extended by dotted lines as shown. The width of any given tooth and space combined, measured at right angles to its length, is the normal circumferential pitch of the tooth, which equals $\frac{\pi}{P}$. The entire width, then, of N teeth, laid side by side as shown in the figure, amounts to $N \times \frac{\pi}{P}$. An examination of this sketch will also show that $\pi D \times \cos. a = N \times \frac{\pi}{P}$. Solving this equation in



Spiral Gear Dimensions.

turn for D and P, we have

$$D = \frac{N}{P \times \cos. a} \quad (1) \qquad P = \frac{N}{D \times \cos a} \quad (2)$$

We know that the pitch diameters of our two gears are to be equal; calling one gear a and the other b, and giving the letters in the first formula sub letters to correspond, we have

$$\frac{N_a}{P \times \cos. a_a} = \frac{N_b}{P \times \cos a_b}$$

If one of our gears were to have 20 teeth and if the ratio were to be 2 to 1, then the other gear would have 10 teeth. Substituting 20 and 10 for N_a and N_b, respectively, then reducing, and eliminating P, we have

$$\frac{2}{\cos. a_a} = \frac{1}{\cos. a_b}$$

Remembering that a_a is the complement of a_b, since the shaft angle is 90 degrees, we have (rearranging the equation):

$$2 \sin a_a = \cos. a_a$$

In order, then, to find the proper tooth angle to meet the conditions, we find in a table of sines the angle which has a cosine equal to twice the sine. This angle is found to be 26° 34′, which will be the proper tooth angle for the 20-tooth gear. The angle for the 10-tooth gear will be its complement, or 90° — 26° 34′ = 63° 26′. Using Formula 2 to find the pitch, filling in the letters to agree with the data for gear a, we have

$$P = \frac{20}{2 \times 0.89441} = 11.18$$

which is the diametral pitch of the cutter for the given conditions. The other dimensions required, such as the thickness of the tooth, the length of the spiral, the series number of the cutter required, and so on, can be found by the rules given in the article in the May, 1906, issue of MACHINERY, entitled "A Method of Procedure in the Design of Helical Gears."

We do not know that this solution meets your requirements. It would be possible to keep the center distance between shafts the same, number of teeth the same, but vary the diameters somewhat, making one of the gears larger than the other, and by so doing have the pitch of the cutter 10 exactly; then a stock cutter could be used. Or it would be possible to vary the center distance slightly, keep the gears of equal diameters, 10 and 20 teeth respectively, and be able to use a stock 10-pitch cutter. It is not possible to use a 10-pitch cutter under the conditions you have prescribed.

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

ATTACHMENTS FOR BROWN & SHARPE MILLING MACHINES.

The Brown & Sharpe Mfg. Co., of Providence, R. I., has recently completed a series of attachments for its latest line of milling machines. This entire lot of attachments is new in design. They are all so constructed as to be bolted directly on the extended knee slide of the milling machine, this method of attachment being at once rigid and convenient. The list comprises a slotting attachment, rack cutting attachment, indexing attachment for table, high-speed milling attachment, vertical spindle milling attachment, compound vertical spindle attachment and universal milling attachment.

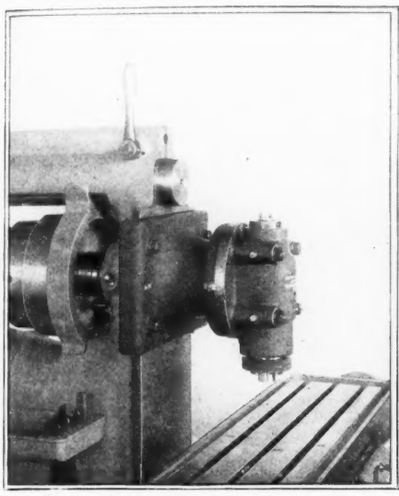


Fig. 1. Vertical Spindle Attachment.

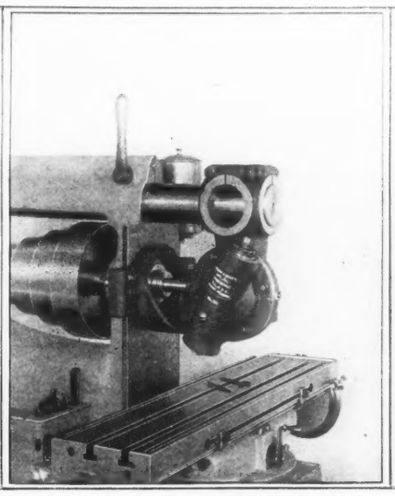


Fig. 2. Compound Vertical Attachment.

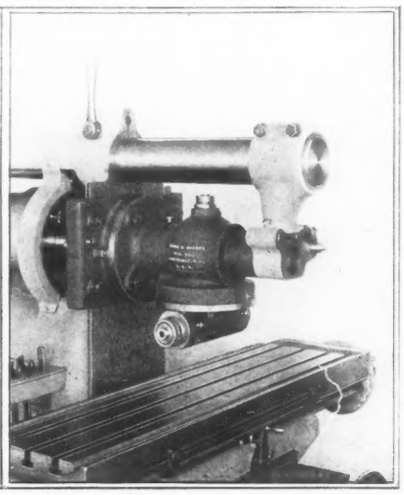


Fig. 3. Universal Milling Attachment.

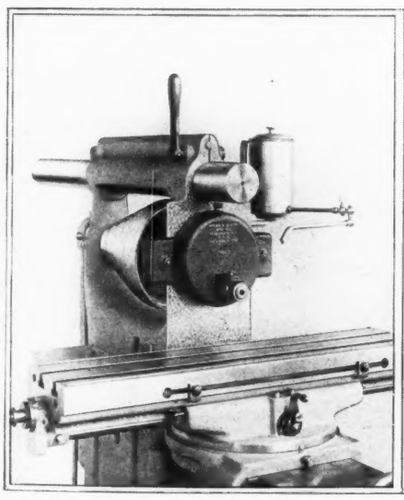


Fig. 4. Device for High-speed Milling.

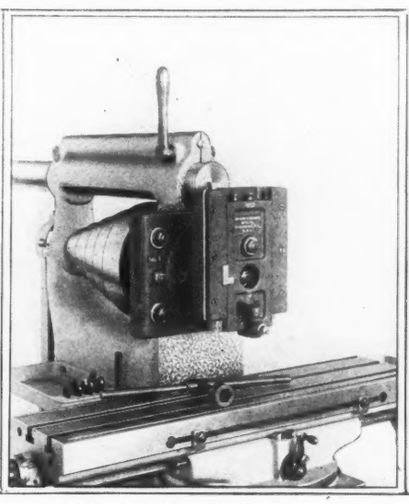


Fig. 5. Slotting Attachment.

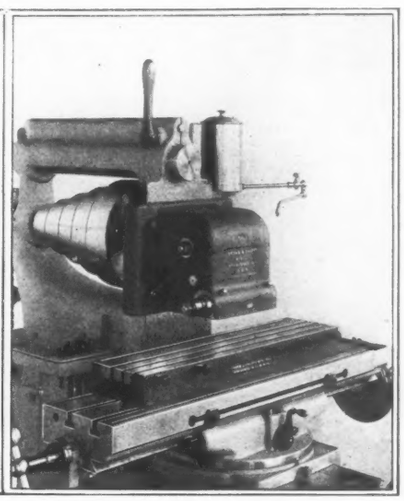


Fig. 6. Rack Cutting Attachment.

Fig. 1 shows the form of vertical spindle milling attachment used on the smaller machines up to the No. 3 heavy plain and universal sizes. The spindle is of steel, ground, and running in bronze boxes provided with means of compensation for wear. It is driven through hardened steel bevel gears. It can be set at any angle from a vertical to a horizontal position, the angle being indicated by graduations on the side of the head, reading to degrees. The spindle is provided with a tapered hole, and is threaded for face milling cutters. A drawing-in bolt is furnished for holding collets, etc., in the spindle. The larger sizes have a groove milled across the end of the spindle for engaging driving tongues on arbors, cutters, etc. The means provided for attaching the device to the front of the column are plainly shown in the cut.

For the milling machines, both plain and universal, larger than the No. 3 heavy size, a modified form of this vertical spindle attachment is used. This was described and illustrated in the new tools column of the June issue of MACHINERY. A still lighter form is used for high-speed vertical milling. This follows the general construction of the firm's original vertical attachments, being clamped to the over-hanging arm, and driven by spiral gears from a keyed arbor in the main spindle.

Fig. 2 shows the compound vertical spindle attachment. It is applicable to a large variety of milling operations, since it can be set to swivel in either of two planes. It is held rigidly in position, the upper part of the head or frame being clamped to the over-hanging arm, while the lower part is fastened by a heavy bracket to the face of the column. The spindle is driven through steel bevel gears, by a horizontal shaft inserted in the main spindle of the machine. The possibility of setting the spindle to an angular position in a plane at right angles to the table is a valuable feature in milling angular strips, table ways, etc., since with this arrangement the full length of the table travel is available, and an ordinary end mill can be used, instead of a special angular cutter.

In Fig. 3 is shown the universal milling attachment. This is clamped to the knee slide on the column at one end, and to the over-hanging arm at the other. It is fully universal, and is applicable to a great variety of work: drilling, milling angular slots or surfaces, cutting spiral gears at any angle, cutting racks, milling key seats, etc. This variety of work is made

possible by the fact that a double swivel is provided. The attachment may be swung bodily about the axis of the machine spindle, and the cutter spindle of the attachment may also be swiveled about an axis at right angles to the first. Both adjustments may be read from graduations, as shown in the cut.

Fig. 4 shows a high-speed milling attachment. This is useful for drilling small holes and driving small end mills. The device is simple in construction, no extra belt or auxiliary device being required for attaching it to the machine. The mechanism is enclosed and protected from dirt and injury. As many speed changes are available as are provided for in the design of the machine itself. The spindle is driven

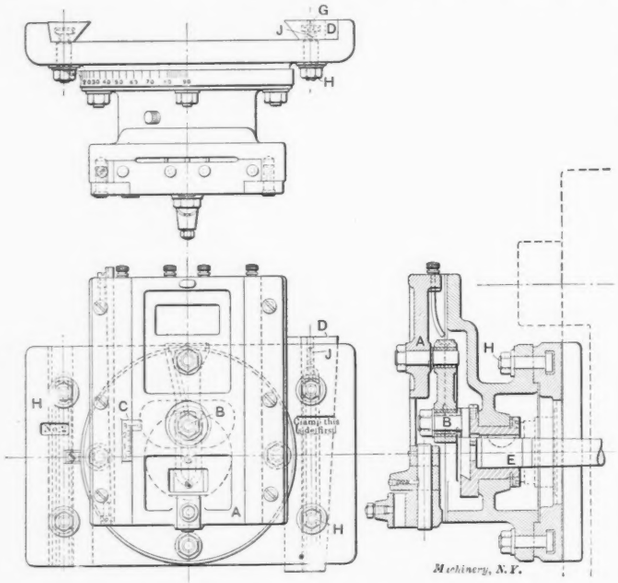


Fig. 7. Details of Slotting Attachment.

by an internal gear, screwed onto the main spindle of the miller, meshing with a pinion on the spindle of the attachment.

The slotting attachment shown in Fig. 5 is unusually well adapted to toolmaking, die sinking and work of a similar character. It is of simple construction, as may be seen from the line cut, Fig. 7. The device is entirely independent of the over-hanging arm, being clamped to the face of the machine column. The tool slide *A* is driven from the main spindle of the machine by an adjustable crank *B*, which allows the stroke to be set at different lengths. These varying lengths are indicated by a graduated scale at *C* on the front of the attachment. The slide swivels about the machine spindle, and can be set at any angle from the vertical to the horizontal without affecting the length of the stroke. The setting is indicated by graduations on the side of the swivel head, reading to ½ degree. The attachment is entirely self-contained, no auxiliary belting being required when mounting it on the machine. An interesting detail in the design is the provision made for allowing for variations in the width of the extended knee slide on the column to which the attachment is clamped. An adjustable gib, *D*, is provided on the right-hand side. This is tapered and fits a tapered bearing in the body of the attachment. It may be adjusted vertically by screw *J* until the spindle *E* of the attachment is exactly in line with the tapered hole in the end of the machine spindle. This vertical adjustment of *D*, of course, shifts the whole attachment horizontally. When it has been thus centered, it may be locked in position by check screws *G*. Then it may be removed and replaced on the same machine indefinitely without further adjustment, the four nuts *H*, on the front, being used for fastening it in place.

The rack cutting attachment, shown in Fig. 6, is particularly adapted to the cutting of racks, and the cutting off of stock, etc. It is fastened to the machine in the same manner as the previous device. All the working parts are entirely enclosed, thus protecting them from dirt and injury. The cutter spindle is hardened and ground, and runs in bronze boxes, of which the one at the front end is provided with means for compensation for wear. It is smoothly and powerfully driven from the main spindle of the machine through hardened steel bevel and spur gears. Special vises are furnished for holding the work. That for the Nos. 1 and 2 sizes has jaws 26 inches long, which will open 3 inches. That for Nos. 3 and 4 attachments has jaws 36 inches long, with an opening of 4 inches. With this rack cutting attachment, a special indexing device is generally used. This consists of a bracket, fastened to the table T-slot at the left-hand end, carrying a locking disk, together with change gears for connecting it to the feed screw. By its use, racks may be cut, and longitudinal settings made, without the necessity for relying on the graduated dial usually employed for the purpose. Change gears are furnished for cutting teeth as follows: The diametral pitches from 3 to 6 by half sizes, all pitches from 7 to 16, and even pitches from 18 to 32 inclusive; and circular pitches 1 inch to 1-16 inch by 1-16 inch. With a few additional gears, the attachment can be used to cut metric racks with an English screw. With machines furnished with the metric screw, the gears give modules of from 1 to 8, and all circular pitches from 2 millimeters to 16 millimeters, inclusive. An index table giving these various settings is furnished.

PLURALITY DIE BOLT CUTTER.

The principal feature of this machine, made by the Mummert, Wolf & Dixon Co. of Hanover, Pa., is the die. The front elevation of the machine is shown in Fig. 1, while the die head will be more clearly understood from an inspection of Figs. 2 and 3, where the dies used are shown both in place in the head and dismounted. These three dies or chasers have, as shown, twelve cutting points each, and they may be indexed to bring any one of the cutting edges into working position, so that twelve sizes of thread may be cut without changing the tools. With this arrangement all the varieties of threads commonly used can be cut with one or two set of dies, it not being necessary to have a large number of loose parts as is the case with the ordinary construction.

The head is simple in construction, as may be seen in the sectional view, Fig. 4. The dies are held firmly by tempered tool steel studs with notched heads at the back, engaging locating disks having notches corresponding with points on

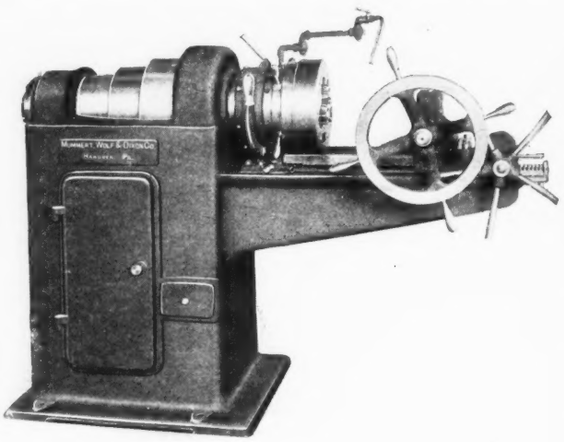


Fig. 1. Bolt Cutter with a Plurality of Dies Instantly Available.

the dies. These provide means for locating the points when changing from one size to another. It is not necessary to remove the dies in changing the adjustment. The partly countersunk nut on the front of each die, shown in Fig. 2, is loosened and the stud is pushed back, thus disengaging the connection between the locating disk and the bolt. The die can then be turned until the guiding surface wanted points toward the center. The spring then pushes the stud forward into place and the nut is again tightened. This can all be done very quickly. The dies can be adjusted while the machine is running by turning the four-handle adjusting

ring back of the head. This ring is graduated so that the amount of the adjustment is easily obtained. The machine has a simple, positive automatic throw-out. Arrangements for automatically closing the dies are also provided for, and are furnished when desired.

There is no gearing exposed in this machine. As shown in Fig. 4, the back gearing is suspended beneath the cone pulley in the main casing. The front bearing is long and close up to the head. The part of the spindle running in this bearing is provided with means for taking up the wear. The oiling system and the means provided for disposing of the chips are also clearly shown in this cut. The oil pump works properly when run in either direction, so that it is not necessary to change the belt when cutting left-hand threads. The construction of the vise and carriage is clearly shown in Fig. 1.

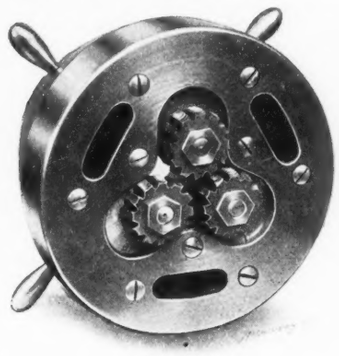


Fig. 2. Front View of Opening Head, with Cutter Mounted in Place.

The die system used presents a number of advantages.

Fig. 3. Multiple-faced Cutters.

Fewer parts are necessary to cover a wide range of sizes. The dies may be arranged to have fewer points, or the sizes most used may be duplicated. The dies are made so that all points of the same size are interchangeable with each other on the same set of dies, or any point of the same size will

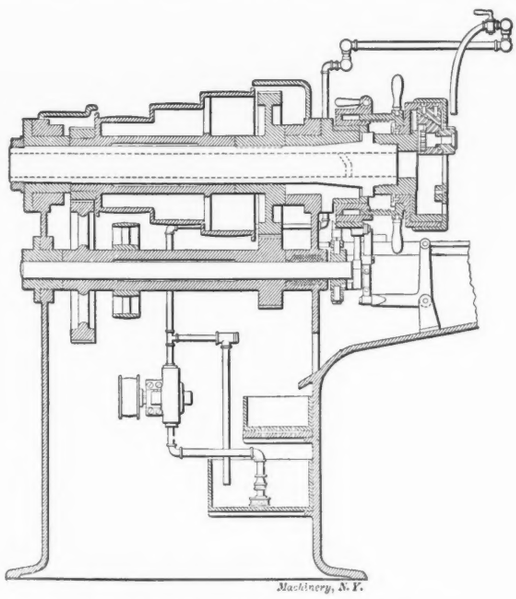


Fig. 4. Sectional View of Mechanism of Bolt Cutter.

interchange on the same number die of any other set. Thus, if the working edge of one die of a set should be broken or be worn out, the remaining two cutting edges on the other dies may be used with another cutting edge of the same size on the same die, or any other die of the same number. Three dies constitute a set. By using three dies the stock is more readily held central, so that one die cuts just as much as another. The dies can be easily sharpened, the same as ordinary chasers, by grinding with a V-shaped wheel. The machine is fully covered with patents and pending applications.

MUELLER FOUR-FOOT STANDARD RADIAL DRILL.

The Mueller Machine Tool Co. of Cincinnati, Ohio, has recently perfected the radial drill shown in the accompanying half-tone. Aside from the constructional features which give it the stiffness and driving power required for tools to work under modern shop conditions, the machine is interesting in the means provided for changing the speeds and feeds. Twenty-four changes of speed are given to the spindle, and eight changes of automatic feed for each spindle speed. Any one of these spindle speeds may be instantly obtained while the driving belt is in motion, without noise or shock, and all of them are absolutely positive.

The two long levers shown in front of the speed box control four changes, the small locking lever shown between the two preventing the possibility of more than one speed being engaged at a time. In Fig. 2 is a diagram of the speed box, gearing shafts, and friction clutches. The latter are operated by the two long levers just mentioned, and connect the driving shaft with either one of the four gears *A*, *B*, *C* and *H*.

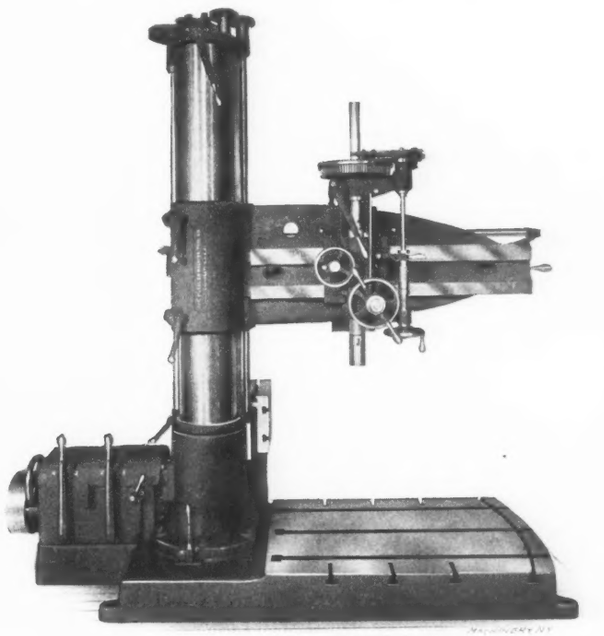


Fig. 1. Mueller Radial Drill.

These gears mesh respectively with A_1, B_1, C_1 and D on the intermediate shaft, which may thus be driven at any one of four different speeds, depending on which friction clutch is engaged. The small lever on the right side of the speed box is used to bring gears D_1, E_1 and F_1, which slide on the upper shaft of the speed box, in mesh with the corresponding gears *D E F* fixed on the intermediate shaft. Three more changes of speed are thus obtained, which, multiplied by those on the first driving shaft obtained by the clutches, give twelve changes of speed; this number is doubled by the back gears located on top of the column, giving twenty-four changes in all. The latter gears are shifted by the lever shown at the base of the column. This lever is also used to bring the gear on the center shaft in mesh with the gear on the elevating screw, when this is required. When the elevating screw is to be reversed for lowering the arm, gears D_1 and G in Fig. 2 are brought into mesh, causing the upper shaft in the speed box to run in a reverse direction at an increased speed.

The column is stationary, made in one piece, and has a heavy section throughout. It is bolted to the base and does not revolve. It has four webs extending its entire length,

adding to the strength of the machine, and serving to resist heavy strains at any height, particularly when the arm and spindle are at their maximum travel. The arm is of cylindrical section with its upper brace as close to the head as possible. The lower brace is at the outer edge. This construction prevents twisting of the arm, while resisting upward pressure due to the thrust of the drill. A top cap on the column, resting on roller bearings, supports the arm, which is able to make a full circle about the column if necessary. It is instantly locked by fixed binding levers. The arm is lowered at almost three times the elevating speed, by a screw having ball thrust bearings.

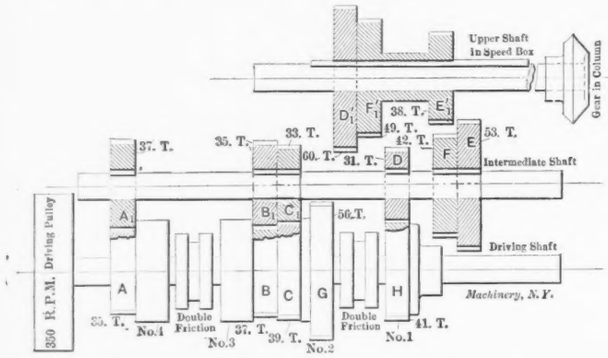


Fig. 2. Arrangement of Clutches and Gearing in the Speed Changing Mechanism.

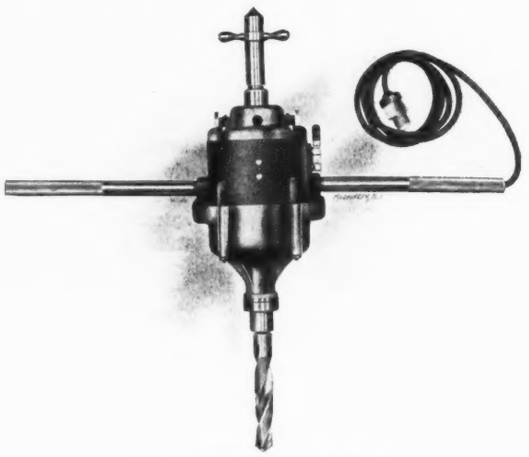
The spindle is made of crucible steel, carefully ground. It is counterbalanced, has quick advance and return, and its bearings have provision for taking up wear. It is started, stopped and reversed for tapping by the long lever shown in front of the head, which operates two self-adjusting noiseless friction clutches, located at the back of the head. When used for tapping it is impossible to accidentally engage either the automatic or the lever feed, so that the breaking of taps from this cause is avoided. An adjustable gage nut causes the spindle to slip when the tap reaches the bottom of the hole.

The feed used is similar to that described in the January, 1906, issue of MACHINERY. It provides for a positive feed, quickly changed while the spindle is in motion. This may be used for high-speed drills and reamers. When a friction feed is desirable, the operator can easily make the change from one to another by turning a single nut. An automatic trip to this feed is provided, which has a safety stop to prevent the feeding of the spindle after it reaches the limit of its travel. A graduated bar on the counterbalance weight is set to zero when the drill enters the work. The bar has several adjustable dogs to trip the feed as often as desired. These do not interfere with the spindle travel. The feed can also be tripped by a lever on the vertical feed rod.

HISEY PORTABLE ELECTRICAL SCREW FEED DRILL.

The motor for this drill, which is made by The Hisey-Wolf Machine Co., Cincinnati, Ohio, is entirely enclosed at the spindle end, so that borings and chips of metal and wood are prevented from entering the casing and interfering with the action of the gears and commutator. The gears and other working parts are hardened. All the parts are easily accessible for adjustment, though fully protected from accident. The tool is simple and compact, with no complicated parts to get out of order, and is especially built for the heavy work it is intended to perform. The switch is located on the body of the motor, within immediate reach of the operator. The two side handles are detachable. An "old man" is furnished as an extra, if desired.

These portable electric drills are particularly useful in machine shops, boiler plants, bridge building, construction work, and ship yards. They can be carried anywhere, as any length of lamp cord can be attached. This style is made in two sizes: the ⅞-inch size with a weight of 27 pounds, and the 1¼-inch size with a weight of 38 pounds. The figures given refer to the diameter of hole it is possible to drill

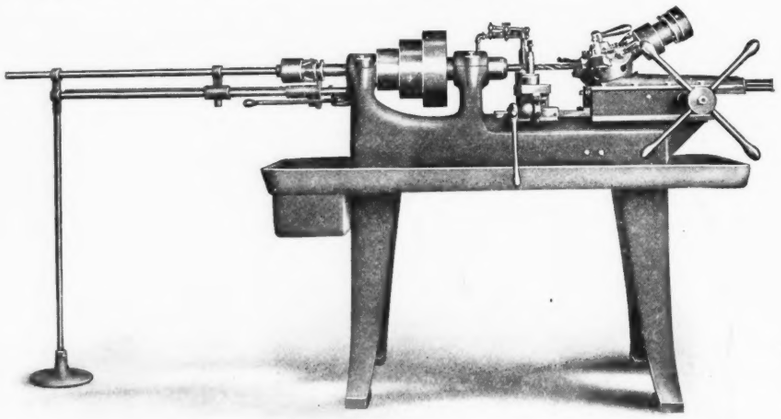


Electrical Drill for Heavy Work.

in steel with the tool; larger sized holes can be made in softer material. Hand drills in smaller sizes, and Scotch drills up to 2 inches capacity, are also made by the same firm.

THE "TILTED TURRET" LATHE.

This machine has been designed to meet the demand for a screw machine or monitor lathe whose turret will carry tools of sufficient diameter to properly handle the work, and also allowing short box tools to be bolted to the faces of the turret, and still permit a long piece to be machined.



The "Tilted Turret" Lathe.

The general design of the machine is shown in the accompanying cut. It is equipped with wire feed. The bearings are self-oiling, and one filling of the chamber under the bearing will lubricate the machine for a year. The turret is hexagonal and is fitted with holes and binder bushings for round-shank tools, and has its faces square with the spindle for attaching tools. It is mounted on a slide rest at an angle of 15 degrees with the horizontal. By this arrangement a tool, when swung over the turret slide, is set at an angle of 30 degrees with the horizontal, thereby permitting the use of a tool two or three times the diameter possible on other styles of turret lathes. Another great advantage of this machine, a feature which is found in no other, lies in the lower row of holes in the turret.

It will be noted from the accompanying cut that the work is arranged to pass directly through the turret and back over the turret slide without interfering in any way with the tool which might be in the back hole or fastened to the rear face. This feature is a very important one, as long stock may be handled without necessitating a tool with an excessive

overhang. It will be further noted that the pressure on the turret is taken up directly on the turret slide, which comes nearly on a line with the center of the spindle, in this manner relieving the center post of the turret from undue strain and consequent springing.

Each hole of the turret has an independent stop, shown at the rear of the turret slide; and by a new construction these stops are stationary and do not revolve with the turret. The turret slide and saddle have gibs for adjustment, both vertically and crosswise, to take up wear and preserve the turret alignment.

The oil-pan is large and has a tank cast in the head-stock end with a pump to force the oil to the work. A double cut-off rest is provided, having an extra long bearing on the bed with an adjustable gib. The countershaft is of the rim friction type, and the friction clutch has but four working parts. Both pulleys and bearings are self-oiling and can be operated for six months steadily without attention.

The machine, as shown, takes 1-inch stock through the wire feed, and other sizes are now under process of construction at the factory. It is made by the Wood Turret Machine Co., of Terre Haute, Ind., and is being put on the market by Hill, Clarke & Co., Inc., 156 Oliver St., Boston.

THE FARWELL QUICK-CHANGE HAND MILLING MACHINE.

The interesting series of half-tones shown with this article illustrate the wide variety of work which can be conveniently taken care of by the hand milling machine shown in Fig. 1.

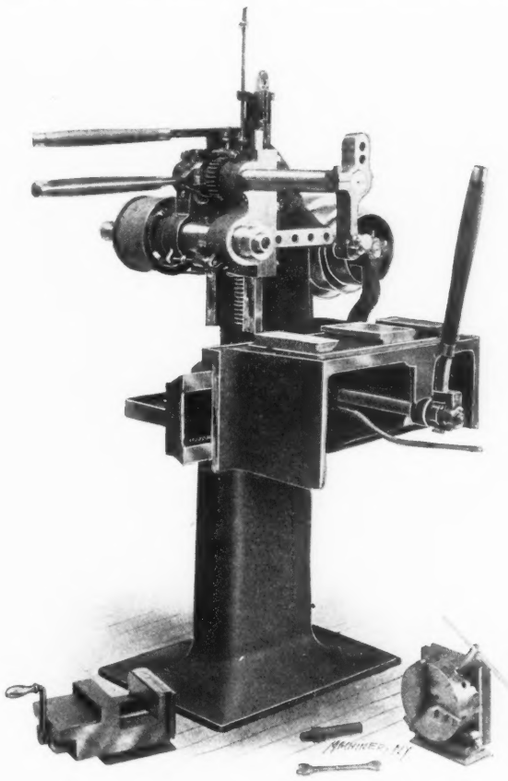


Fig. 1. Farwell Quick Change Hand Miller.

This is known as the Farwell "quick-change" hand milling machine, and is built by The Adams Co., of Dubuque, Iowa. It will be seen to differ radically in construction from most other machines of its kind. For instance, the cross travel is secured by the endwise movement of a quill carrying the spindle, operated by the upper of the two levers on the column, while the vertical travel is provided for by the sliding of the spindle head vertically on the main casting. This arrangement makes it possible to have but one sliding surface (that for the transverse movement) between the work table and the main frame of the machine, instead of the three surfaces usually necessary, and the rigidity thus obtained makes it possible to do heavier work than ordinarily attempted on hand machines. The use of high-speed milling cutters still further increases the range of the tool. With the old carbon steel cutters, when the tooth contact was comparatively slow, power feeds were required to get the slow, steady movement necessary to produce true smooth surfaces, but when high-speed cutters are used, with the tooth contact nearly quadrupled, the surface produced by hand-fed mechanism is satisfactory, while the rapidity of operation, particularly on short cuts, is greatly increased.

The spindle is driven from a 3-step cone, connected to the slide by an adjusting rod for preserving the proper belt tension; with the two-speed countershaft provided, this gives six changes of spindle speed. As shown, an overhanging arm is provided, carrying an arbor support on the outer end. This support may be removed and the arm pushed back out of the way when it is not needed. Provision is made at the other end of the arm for holding studs for former rolls to use in profiling, cam cutting, etc. For the same purpose, a bracket is provided, extending rearwardly from the front end of the spindle slide, in which guide pins or rolls may be held at distances of 4, 6, 8 and 10 inches from the spindle. The way in which these provisions are made use of will be described later. The head is provided with adjustable stops for limiting the vertical motion in either direction, and is counterbalanced by weights inside the column. These weights may be added to or diminished, in the same way as is done with scale weights, so that the head may be over-balanced to feed upward, under-balanced to feed downward, or left in equilibrium for hand feeding.

The machine gets the name "quick-change" from the arrangements provided for quickly locking and unlocking the various adjustments, relocating the positions of the levers, and changing the various fixtures provided. The three levers shown, controlling the cross, vertical and transverse movements, respectively, are all connected to similar mechanisms, so that when any one of them is given a movement at right angles to the feeding movement, its slide is tightly locked. This operation at the same time disengages the lever from the shaft of the pinion controlling the movement, so that it may be freely swung to a new position if desired. This is a great convenience in profiling, or when feeding in two directions. By this means the table may be locked, the cutter fed into the work to the proper depth, and the spindle head locked in turn, after which the table may be released and the longitudinal feed begun, all without the use of wrenches, or without requiring the operator to remove his hand from either of the levers.

Two fixtures are regularly provided—the vise and the indexing chuck shown on the floor near the machine. Special provision is made in the design of the table for holding these. In addition to a ⅝-inch T-slot, the table is provided with two clamps, operated by levers beneath it. The chuck, vise, or other fixture is provided with ways which slide in between these clamps, so that it may be secured in any position by a single turn of the lever.

The vise furnished with the machine has jaws 6 inches wide, 2 inches deep, and opening 3 inches in the normal position. By reversing the sliding jaw, as shown in Fig. 4, the vise will hold work 6 inches wide. It is exceedingly heavy and provided with engaging flanges so that it may be secured in the quick-changing clamps in two vertical, as well as in two horizontal positions. The three-jawed chuck furnished is 6 inches in diameter, has two sets of jaws, and will take 1 9-16-inch stock through the center. It is mounted on a heavy angle plate, which may be secured by the quick-acting clamps to the table in one horizontal and two vertical positions. Twenty-four stops or graduations are provided which are convenient in spacing cutters, laying out keyways on quarters or opposite sides of the shaft, or for squaring or milling hexagon heads. It may be used conveniently for circular milling, as well, as shown in Figs. 5 and 6.

In Figs. 2 to 10, inclusive, are shown a number of operations, giving some idea of the varying range of work for which the machine can be used. In Fig. 2 is shown a delicate milling operation with a fine cutter on a comparatively large casting. Work of this kind is easily performed on this machine, since the sensitiveness of the hand feed in vertical

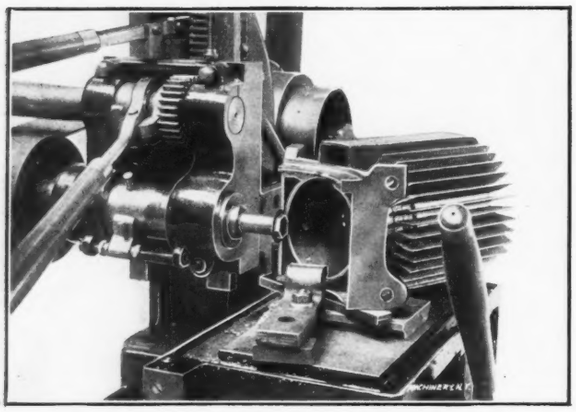


Fig. 2. A Small Cutter Working on a Cylinder Casting.

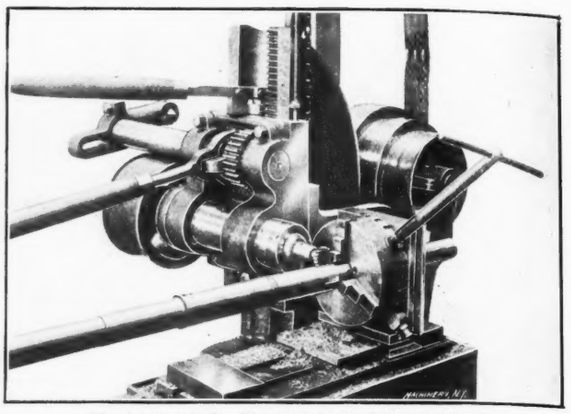


Fig. 3. Quartering Keyways in the Indexing Chuck.

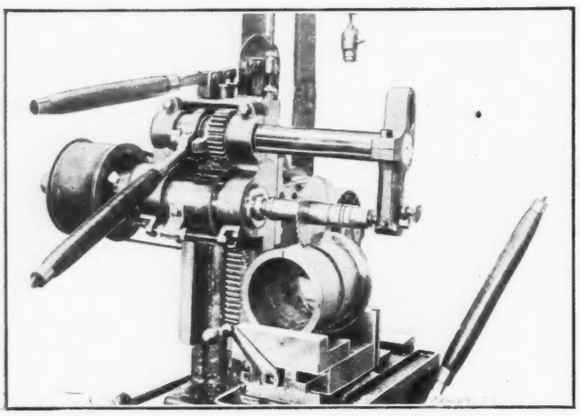


Fig. 4. Vise, with Jaw Reversed to Increase Capacity.

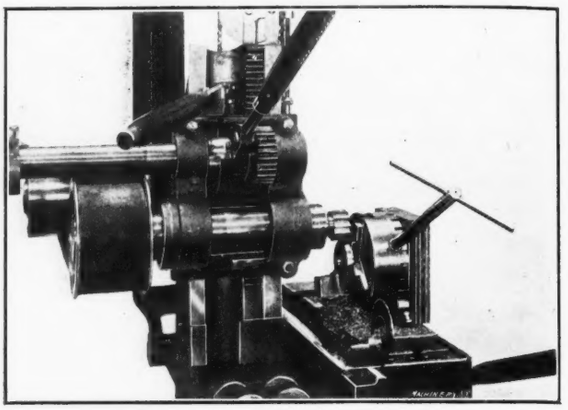


Fig. 5. Circular Milling with Rotating Vise.

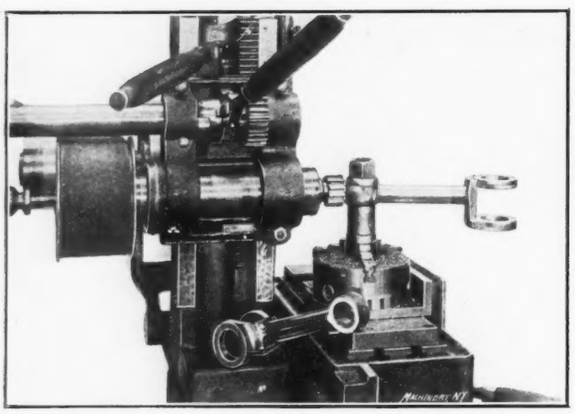


Fig. 6. Another Case of Circular Milling, with End Mill.

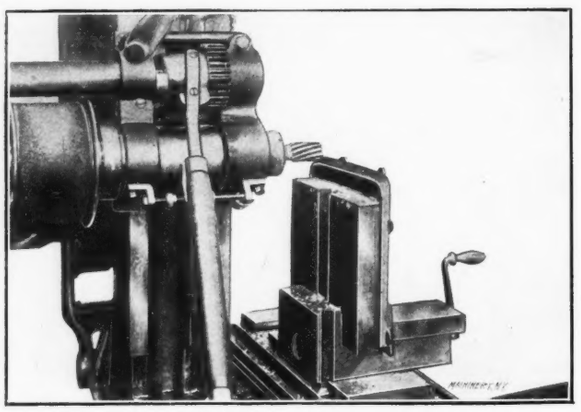


Fig. 7. Long Cuts in Two Directions, Performed in One Operation.

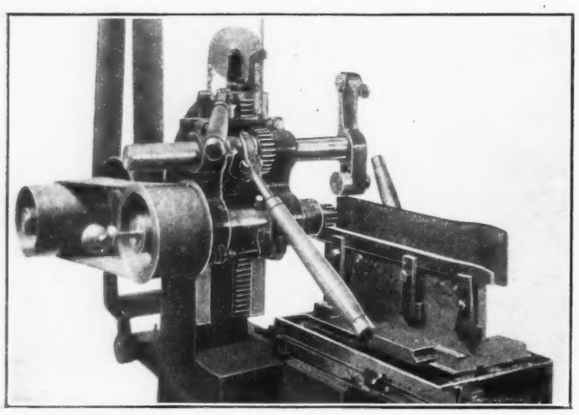


Fig. 8. A Profiling Job.

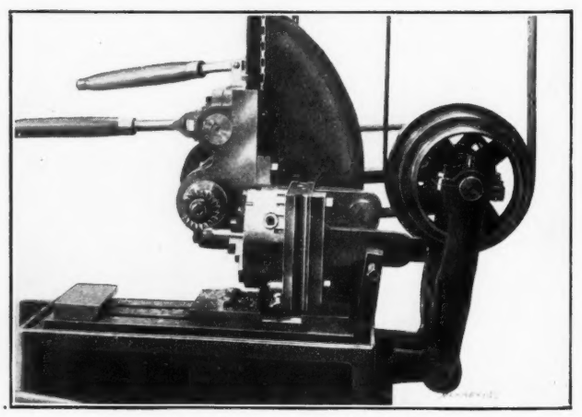


Fig. 9. Cutting a Ball-shaped Mill.

movements is preserved, no matter what the weight of the work may be, the vertical feed being obtained by the travel of the head instead of the work. In Fig. 3 the chuck is shown holding a shaft which is having keyways milled in it at positions 90 degrees apart; the same attachment is also shown in Figs. 5, 6 and 9. In Fig. 4 the vise is shown with the sliding jaw reversed to increase its capacity; the method of holding the vise to the table, previously described, is plainly seen in this cut and in Fig. 7.

Examples of circular milling are shown in Figs. 5 and 6. In the first of these the axis of rotation is horizontal, and parallel to that of the spindle. The chuck holding the work is rotated by a suitable handle, inserted in the socket provided for it, as shown later in Fig. 10. In Fig. 6 an end milling cutter is used to finish the outside of the hub of the

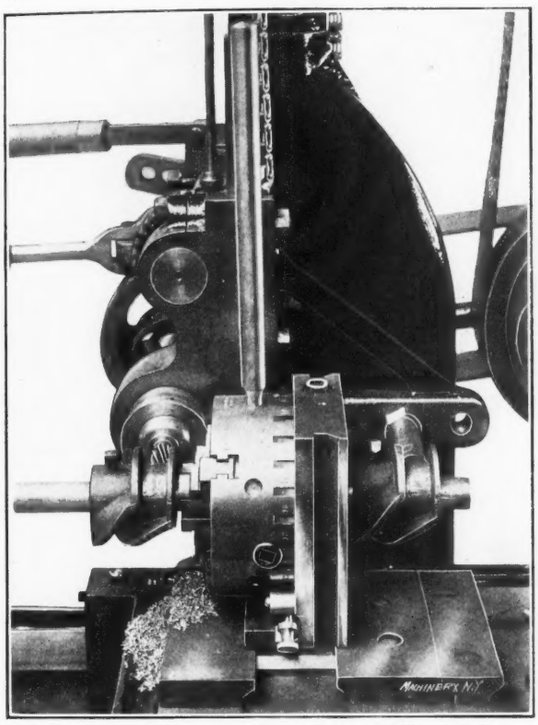


Fig. 10. Cam Cutting with Master Cam and Follower Roll.

link shown. Here the work itself is of such shape that it can be conveniently grasped by the hand of the operator and fed past the cutter.

In Fig. 7 is shown a piece of work in which there are both longitudinal and vertical feeds, each of them of some length. A piece of work of this kind well shows the advantages of the lever mechanism used on the machine, since it requires feeds beyond the range of a single movement of the lever, and requires a change in the direction of the feed from one lever to the other. These numerous changes in adjustments are all accomplished without requiring the workman to remove his hands from the work levers controlling the two feeds.

In Figs. 8, 9 and 10 are shown some suggestive cam-cutting and profiling operations. The first of these shows a bar being milled to the proper contour for a machine handle. A stud with a copying roller is clamped in the overhanging arm; this roller bears on a former held in a fixture clamped to the work table. This fixture is held by the same means as is provided for the chuck and vise. The spindle head has a large part, if not all, of its counterbalancing removed, so that its weight is effective in keeping the copying roller down on the former. As the table is fed along by the lever controlling it, it will be seen that the work is profiled to agree with the former. In Fig. 9 a round-ended mill is being made. This is also a profiling operation. In this case a bracket carrying the former is bolted to the back side of the base of the three-jawed chuck. The copying roller is held on a stud in one of the holes in the bracket attached to the spindle head, as previously described. As in Fig. 8, the unbalanced weight of the spindle head keeps the roll in contact with the former, thus guiding the cutter to form the ball-shaped end of the mill which is being made.

In Fig. 10 the machine is shown at work on a cam-cutting operation. The former and the cam to be cut are each fastened to a shaft passing through the three-jawed chuck, which is held in the same way as in Fig. 9. In this case also the former roll is mounted on the bracket extending backward from the spindle head. This head is locked, however. The cam and the former are rotated by the long handle shown inserted in the periphery of the chuck. As the work is thus slowly revolved, the action of the roll and the former shifts the table backward and forward in such a way as to duplicate the curves of the master cam on the cam being cut.

The table of this machine has a working surface of 18 inches. The length of the table feed is 18 inches, the vertical movement of the spindle head is 12 inches, and the longitudinal movement of the spindle is 2½ inches. The spindle is bored to No. 9 B. & S. taper. The spindle bearings are of bronze. The spindle pulley is 6 inches in diameter and 4 inches face, and the spindle, by the mechanism described, may be given six changes of speed, ranging from 70 to 250 revolutions per minute. The net weight of the machine is 1,090 pounds.

THE JOHNSTON CRUDE OIL ENGINE.

The Johnston crude oil engine, shown in Figs. 1, 2 and 3, operates on a cycle somewhat similar to that of the Diesel engine, but is without its disadvantages. The compression pressure usually carried is 150 pounds per square inch, but any compression from 90 to 300 or 400 pounds may be used if so desired. The fuel is injected in a spray at the end of the compression stroke, and is immediately ignited and burned as it enters the cylinder. The ignition is independent of the compression, and is caused by a plate of special alloy fastened to the end of the piston; this plate is maintained at a high temperature by the recurrent charges of oil burning in the cylinder. The first few charges are ignited by a hot thimble, which is heated externally for two or three minutes before starting the engine. When the engine is once started, no further heating is required.

The oil is broken up by means of a specially designed spraying device and compressed air. A two-stage air-pump is attached to the engine, which maintains the air pressure at any desired point, usually 300 to 400 pounds. Storage tanks are supplied with the engine, and compressed air is used for starting, the start without cranking being certain when instructions are followed. The governor acts on the oil-pump and controls the amount of oil injected into the cylinder each working stroke. As the compression pressure remains practically constant under all loads, the economy, when running light, is much better than in the ordinary throttling gas engines.

One of the principal reasons for the success of this engine is the use of a "hot" combustion chamber. Inasmuch as no air is mixed with the fuel charge until the proper time for ignition has arrived, it is impossible for pre-ignition to take place. Hence there is no limit to the cylinder temperature or compression, so far as pre-ignition is concerned. This is an important feature of economy, as high working temperatures are possible—temperatures that are impossible in explosive charge engines. These, in fact, have to waste a large percentage of their heat in waterjackets designed to keep the cylinder walls below the igniting point of the charge. The Johnston engine is so constructed that during the injection and burning of the oil and the early part of the expansion stroke no water-jacketed surfaces are exposed to the charge. The whole interior of the combustion chamber is at such a high temperature that there is no tendency for tar or carbon to accumulate, and after a long run the interior of the combustion chamber will be found perfectly clean, more so, in fact, than if the engine had been run only a few minutes. In very short runs, the temperature does not rise high enough to burn the walls perfectly clean, but even on no load there is no accumulation of carbon.

The question which immediately springs up in the mind of the engineer when hot cylinders are mentioned, is: "What

about the lubrication?" By referring to the section, Fig. 3, the method of providing hot surfaces for the combustion chamber and cool surfaces for the piston and piston rings may be seen. The piston proper works in a water-jacketed cylinder in the usual way, but the piston is constructed with an extension which is 1-16 inch smaller in diameter than the bore of the cylinder, and hence never comes into contact with it. No matter how hot the piston extension may become,

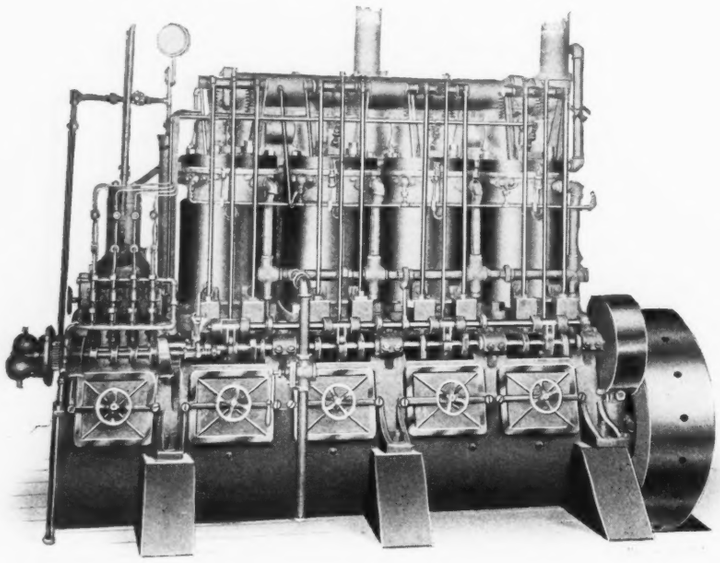


Fig. 1. Johnston 200 H.P Crude Oil Engine.

no harm can result, as there is no contact or friction between the hot parts. The small ignition plate is the only part that deteriorates, this having to be renewed in from six to twelve months.

Samples of every obtainable oil have been tried in this engine, including many grades of crude oil, crude residues, coal oil, gasoline and benzine, without showing any signs of clogging with any grade of fuel. No adjustments whatever are necessary in changing from one fuel to another. A

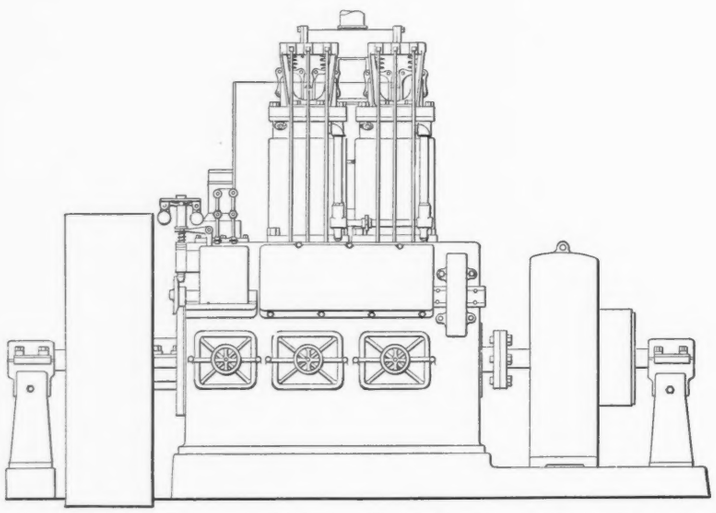


Fig. 2. Johnston 60 H.P. Crude Oil Engine, Side and End Elevations.

9 x 12-inch engine has supplied power for the factory of the company for over a year, using the cheapest grade of crude fuel oil, having an average specific gravity of 0.875 and a flash point 170 degrees F. The fuel consumption in small engines, say of 15 H. P., is ¾ gallon of any kind of oil per 10 horse-power hours, at normal load.

This engine is the invention of H. Addison Johnston, and is built by the Johnston Oil Engine Co., Ltd., Toronto, Canada.

IMPROVED THOMPSON UNIVERSAL GRINDER.

In the September, 1906, issue of MACHINERY we illustrated a universal grinder built by the Thompson Grinder Co., Springfield, Ohio. As will be remembered, one of the interesting features of the machine is the method used to bring the parts into the proper positions to perform work of varying character. The wheel spindle is permanently mounted on a central column, rigidly connected with the base. Around this is a heavy sleeve carrying the knee saddle and work table, with all the mechanisms and attachments necessary for performing widely diversified operations. This sleeve, with all its attached parts, can be rotated around the machine, through an angle somewhat greater than 180 degrees, thus presenting the work either to the face or the edge of either of the two wheels used, or at an angular position with them. A number of improvements have recently been made in this machine, so that it now has the appearance shown in the accompanying half-tone.

The task of devising suitable means for applying a copious supply of water, with the great variety of work of which this grinder is capable, is a difficult one. The successful solution of the problem involved a consideration of the means of delivery of the water and its application, complete drainage of the water from the work and the surface of the machine, freedom of the drainage system and pump from being clogged with sand, ease of access to all parts of the tank and drainage system for the removal of sediment, and, finally, full protection to the journals and gearing. The centrifugal pump has been found to be best adapted to work of this kind, and is therefore used. It is simple in construction, easily accessible, and of such capacity that it does not need to be run at an excessive speed. This pump is placed in a pocket which forms the lowest point in a trough, cast on the base of the machine and completely encircling it. This trough receives the water in any position of the work and table, and forms a depository for the sediment contained in the water; as it is open at the top, the dirt is easily scooped out whenever it becomes troublesome. The trough is of sufficient diameter to extend well outside of the main body of the machine, so that any water which may splash on the smooth sides will drip at once into the reservoir.

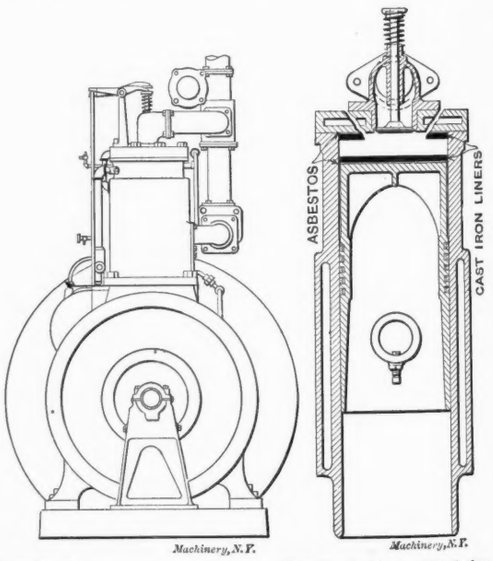
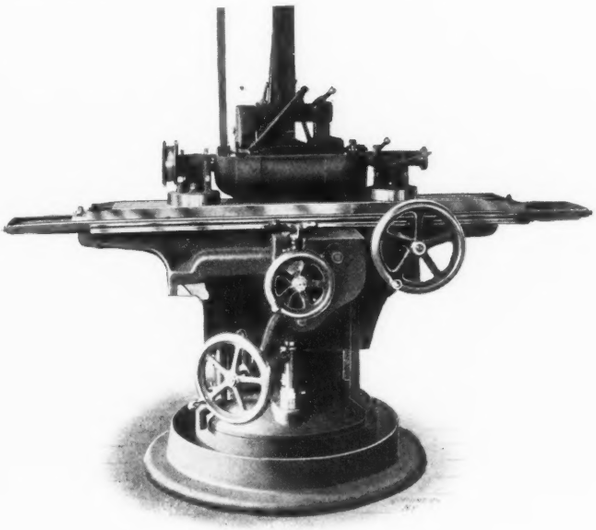


Fig. 3. Section of Cylinder.

From the table, carriage and knee, the water is delivered to the trough through two pipes. From every other part of the machine there are open conduits provided, which

remove all possibility of the drainage system becoming clogged. Since it is useless to try to confine the water exactly to the point where the wheel touches the work, the plan has been adopted of providing for perfect drainage, rather than to try to restrain the flow of the water. The adoption of this principle has necessitated the location of all journals and gears below water-tight decks. The top of the knee casting is solid, and forms a water shed from which lead the two drip pipes shown opening into the trough. There are no other openings in the top of the knee casting, so that the gearing, which is located within, is protected not



Improved Thompson Universal Grinder.

only from water, but from grit and dust. The carriage is entirely closed beneath, so that no water can splash from the top of the knee into the enclosed gearing. Where the casting rests on the ways of the knee, projecting lips are provided which prevent water from entering the bearing surface. So well is the drainage system worked out that if the machine were set out in a rain storm, practically all the water striking it would flow at once into the trough, while all journals and gearing would remain perfectly dry.

A single lever serves to start, stop and reverse the table feed. This lever is seen in the center of the carriage on the top, within easy reach at all times. The hand-wheels for cross and longitudinal adjustments and for elevating the knee are graduated to indicate movements of 0.001 inch.

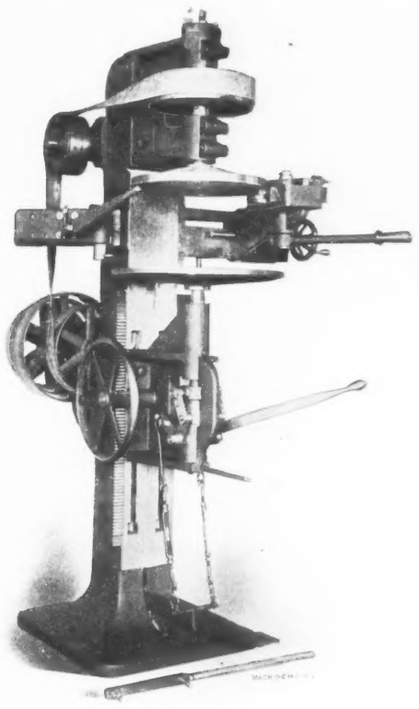
The capacity of the machine will be indicated by the following figures. It will take in between the centers, either 10 or 20 inches in diameter, by 36 inches long. It will grind knives 48 feet in length. The capacity for surface grinding is 8 inches wide by 42 inches long. The cutter grinder attachment provides for work up to 28 inches in diameter. Internal grinding up to 30 inches in diameter and 4 inches in depth is practicable; a special head-stock is used for internal grinding of larger diameters. The makers believe that the variety and dimensional range of the work performed is unapproached by any other similar machine.

BLISS DOUBLE SEAMING MACHINE.

The double seaming machine shown in the accompanying halftone has been recently designed by the E. W. Bliss Co., of 5 Adams St., Brooklyn, N. Y. It is especially designed for use in connection with the manufacture of articles of iron and enamel ware, where the shape of the part to be manufactured is round, as is the case with foot tubs, wash tubs, buckets, and similar articles. One of the improvements introduced is the toggle motion by which the treadle is connected with the bottom or clamping plate. When the treadle is depressed, the toggles are locked and form a positive clamp between the chuck and body, thus allowing the operator to remove his foot from the pedal. At the conclusion of the operation of double seaming the pressure is removed by touching a handle at the right side of the machine, after which the bottom plate drops to its lower position, allowing the article to be taken off and another one to be placed in position to be worked on.

Another point of interest is the smoothing attachment on the left-hand side. In many articles the top edge of the body is wired, and difficulty is often experienced, especially on tapering work, in getting the metal to hug the wire ring closely all the way around. With this attachment it is possible, while performing the double seaming operation at the bottom, to smooth out all the wrinkles formed in the process of wiring, and roll the metal closely over the wire. This adds greatly to the appearance of the finished product without taking any more time.

The adjustments are all easy of access and quickly made. In changing the machine for different heights of bodies, use is made of the rack and pinion seen on the left-hand side of the machine. The adjustments for different diameters of work and depth of seam are made by suitable screws and hand-wheels. One of these can be seen at the back of the



Double Seaming Machine with Smoothing Attachment for Wired Edges.

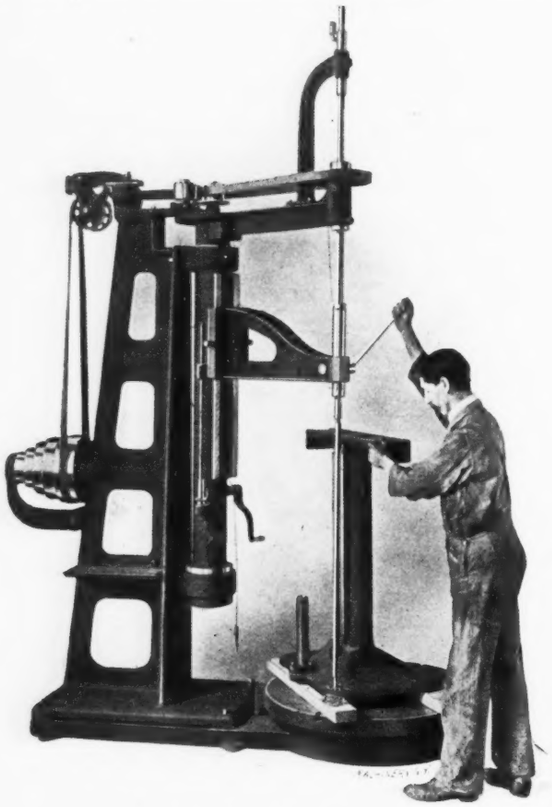
arm which carries the double seaming roll; the other, for adjusting the machine for different heights of seam, is out of sight in the cut. The machine will take work up to 26 inches in diameter and 36 inches in height. It weighs about 3,000 pounds.

HENRY & WRIGHT SENSITIVE RADIAL DRILL.

The machine shown in the accompanying halftone, built by The Henry & Wright Mfg. Co., Hartford, Conn., is somewhat unusual in that it is an application of the sensitive drill-press idea to the radial type of machine. The builders believe that there is a large amount of work of such shape and weight as to necessitate the use of radial drills, in which the holes to be made are of such size that the efficiency of the drilling depends more on speed than feed. To meet this class of work this drill press has been designed.

This machine will drive drills much larger than the ¾-inch size stated as the upward limit of its useful capacity, but the makers lay stress on the fact that this is the first radial drill ever put on the market that will use these smaller drills to advantage. Within its range the results obtained are great enough to entitle this machine to a sure position in the machine shop. As experiments in many cases have

shown, work can be performed 5 or 6 times as fast as with a regular high-grade radial drill. There are other advantages also in the use of the machine, such as a large saving in the power used, due to the elimination of friction in bearings, with a corresponding saving of belting and oiling. There is also an extension of the life of the machine due to the ease with which ball cups and cones on which most of the wear comes, may be replaced. Many of the features of the sensitive drill, built by the same makers, described in the July, 1907, issue of MACHINERY, have been incorporated in this one, such, for instance, as the balance spindle drive, friction pinion, etc.



Sensitive Radial Drill Press.

Friction has been reduced to a minimum by the use of ball bearings, and the driving is done by a single belt, eliminating entirely the use of gears. This gives a very sensitive and economical drive for the work for which the machine is designed. A patented idler device, as shown, makes it possible to use a single belt in the drive, and not interfere with the swinging of the arm through a radius of 180 degrees, with a uniform tension always maintained on the belt. The idler pulleys are arranged to take up slack in the belt, within reasonable limits. Instead of shifting the drill spindle in a sliding head along the arm to bring the drill to the point desired, a round table revolving on balls is used for supporting the work. This makes it easy, in combination with the swinging arm, to bring the drill quickly, and with very little effort, to any position on the work desired. The table is provided with a lock to hold it stationary when in use. A square table is provided to be used in drilling small work, to bring it to the proper height to be drilled easily.

The arm may be raised and lowered by a screw at the side of the column. The screw at the side of the arm provides for clamping it in any position required, and the column, which supports the arm, may be locked in any position by tightening the screws in the bracket provided for the purpose. The arm also has a hole for receiving the guide bar for the tapping fixture.

There are eight changes of speed, with a double speed countershaft run, as recommended, at 90 and 400 revolutions per minute, giving a range of speed at the drill point of from 60 to 975 revolutions per minute.

Although this machine is designed as a radial drill, it may be operated as a stationary drill by locking the revolving table and the arm, and clamping a sub-table to the revolving table by T-slots provided for the purpose.

COX'S PLANING AND SHAPING COMPUTER.

In the July issue mention was made of a Cox time and cost computer for boring and turning, which was distributed by the Bullard Machine Tool Co., at the recent Atlantic City convention of the American Railway Master Mechanics' Association. The veteran designer of this computer, Mr. William Cox, 53 Ann St., New York, has also designed the planing and shaping time and cost computer shown in the accompanying cut. This latest effort of Mr. Cox is consecutive number 120, and it indicates the total number of the computers he has gotten up, covering almost every branch of engineering activity. We understand that this computer is for sale to some one machine tool building concern which would care to use it for advertising souvenirs.

This computer is designed to give the time required for planing any given flat surface on a planing machine or on a shaper. It also gives the cost of performing such work at any wage rate per hour.

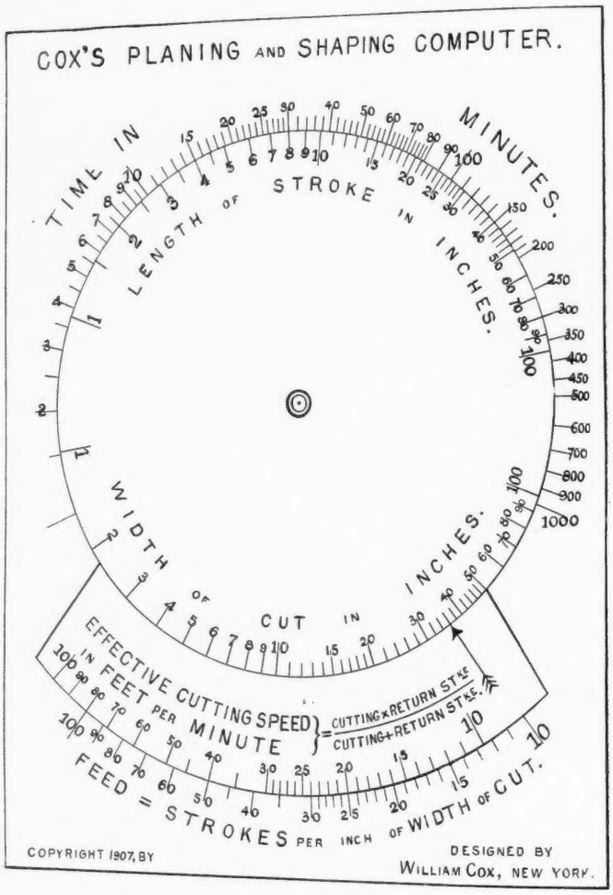
The formula it solves is:

$$\text{Time, in minutes} = \frac{\text{Stroke} \times \text{Width} \times \text{Feed}}{\text{Effective Speed} \times 12},$$

where,

Stroke = length of stroke, in inches;

Width = width of cut, in inches;


COX'S PLANING AND SHAPING COMPUTER.
TIME IN MINUTES.
LENGTH OF STROKE IN INCHES.
WIDTH OF CUT IN INCHES.
EFFECTIVE CUTTING SPEED IN FEET PER MINUTE
FEED = STROKES PER INCH OF WIDTH OF CUT.
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DESIGNED BY
WILLIAM COX, NEW YORK.

Cox's Computer.

Feed = number of strokes per inch of width of cut;

Effective speed = distance in feet covered in one minute by tool *while cutting* $= \frac{\text{Cutting} \times \text{Return Stroke}}{\text{Cutting} + \text{Return Stroke}}$.

The problems solved by this computer are:

1. The time required to plane any given surface of any length of stroke and width of cut, with any feed and cutting speed.

2. To find suitable cutting speed and feed, when the length of stroke and width of cut are known, and the time in which the work *should* be done has been predetermined in accordance with the wage rate, so as to bring the cost down to a given figure.

3. To find the cost of the work done at any wage rate when the required time has been ascertained, and *vice versa*, to find the time allowed for any given cost at any wage rate.

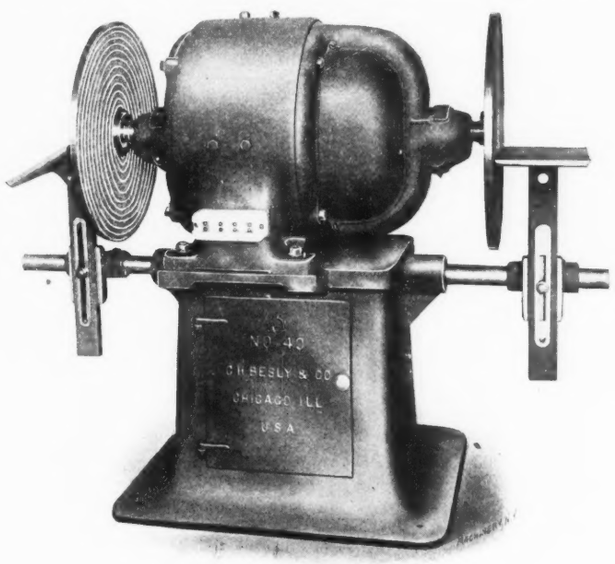
In the cut, a small sector scale for computing the cost is not shown, as it would cover some of the more important parts of the computer.

KRIPS-MASON PRESS ATTACHMENT FOR COUNTERSINKING WASHERS.

The Krips-Mason Machine Co., 1636 N. Hutchinson St., Philadelphia, Pa. (who builds the press illustrated in the March, 1907, issue of MACHINERY, for making washers at one stroke), has recently added an improvement to the dies furnished with this machine. The purpose of this improvement is to countersink the washers produced. The countersink is deep, extending one-third or one-half way through the stock from which the washer is made. It is formed by a conical shoulder on the punch, which forms the countersink while the washer is held firmly on the die, thus making a very neat job.

BESLY NO. 40 PLAIN MOTOR-DRIVEN GRINDER.

Chas. H. Besly & Co., 13, 15, 17, 21 South Clinton St., Chicago, Ill., have built what they believe to be the largest motor-driven disk grinder ever constructed. This is shown in the accompanying halftone. It is a No. 40 plain machine, using 26-inch disk-wheels driven by a 20-horse-power General Electric direct current motor. The motor alone weighs a ton.



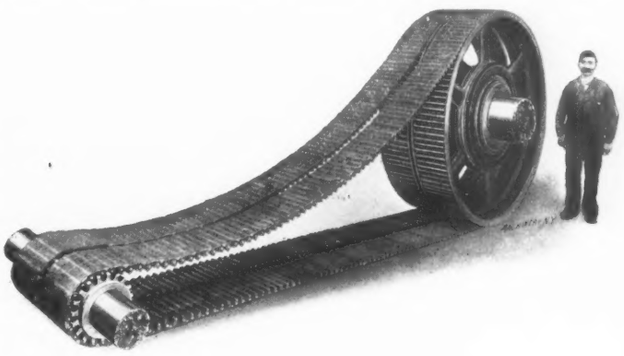
Heaviest Motor-driven Disk Grinder Built.

Four of the builders' patented spiral groove disks are provided with the machine, which is fitted with their regular adjustable tilting table. The controller and starting box are placed in the base of the machine, and may be reached by the door shown in the illustration. This prevents these parts from becoming clogged or short-circuited by powdered steel and abrasives.

RENOLD SILENT CHAIN DRIVES OF UNUSUAL SIZE.

The Link-Belt Co. of Philadelphia, Pa., has recently delivered a Renold silent chain drive of very unusual proportions to the Seattle Brewing & Malting Co., Seattle, Wash. This drive is the largest of this type in the country. It transmits 325 horse-power from the motor to the refrigerating machinery. Two chains, as shown in the cut, are run side by side on single wheels spaced 14 feet from center to center. The load is uniformly distributed by Dodge spring centers on the driven wheel. The peripheral speed of the chain is 1,100 feet per minute.

The Renold silent chain was fully described and illustrated in the August, 1901, issue of MACHINERY. Among its advantages are the facts that the load of the chain is uniformly distributed over all the teeth of both driving and driven gears which are in contact with it; that the stretch resulting from wear of the teeth is compensated by the construction of the chain, which automatically assumes a larger pitch diameter;



A 325 Horse-power Silent Chain Transmission.

and that the noise common with ordinary chain drives is entirely overcome. Even when the Renold chain becomes worn, the maximum efficiency will be maintained, although the demands may be severe enough to incapacitate ordinary drives. The chain will run in either direction and is not adversely affected by heat or cold, dampness or oil.

Another installation also of unusual interest has been furnished for the city of Columbia, S. C., under the supervision of Wm. M. Piatt, the assistant city engineer. This drive operates a Worthington centrifugal pump, and is driven by a horizontal turbine at the unusually high surface speed of 1,755 feet per minute. The shafts are 11 feet 7 inches from center to center, and 224 horse-power is transmitted.

A LINE OF SCREW-THREAD MICROMETERS.

In its work of making tools for accurate screw cutting, the Wells Bros. Co., of Greenfield, Mass., has developed a line of micrometers for the measurement of screw threads. These tools have proved so useful in their own work that they have decided to place them on the market. The system of measurement employed differs radically from that used in any other commercial thread micrometer. As may be seen by examining either of Figs. 1, 2 and 3 (in which various styles are shown) the measurement is taken between two points

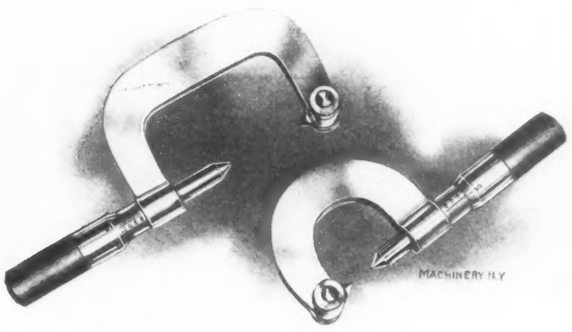


Fig. 1. Screw-thread Caliper made in Hand Micrometer Style.

formed to the angle of the thread, generally 60 degrees. The measuring point in the anvil has a side adjustment by micrometer screw, by which means it is set off from the center line of the spindle by a distance equal to one-half the lead of the screw, for single-threaded screws, or adjusted back to a central position for a double-threaded one. The micrometer spindle has a conical point similar to that in general use with thread micrometers. Both measuring points are flatted enough to clear the bottoms of all United States standard threads

within the range of the tool. This method of measurement, it will be seen, gages the threads on their inclined sides, and so gives what may be called the "pitch diameter," which is the only measurement of any value in determining the fit of a thread.

This principle is applied to the three forms of micrometer shown. In Fig. 1 is what the makers call their "hand thread micrometer." This is made in two sizes, one having a capacity up to and including 1 inch, while the larger one will measure

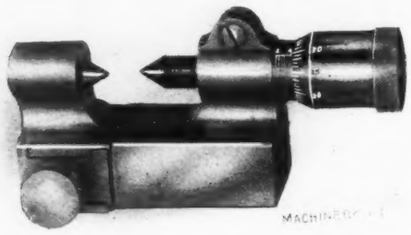


Fig. 2. Thread Caliper with Base, for General Shop Use.

threads from 1 to 2 inches diameter inclusive. In Fig. 2 is shown a "thread micrometer caliper for shop use." It is made somewhat heavier than the hand style, and is mounted on a base of its own. It is considered to be preferable to the micrometer style, in some ways, for the use of manufacturers, and is made in two sizes, the first having a capacity for screws from ¼ inch to 1 inch in diameter, and the larger one from ¾ inch to 1½ inch. The device, which is shown in Fig. 3, is made to cover a large range of sizes, the block

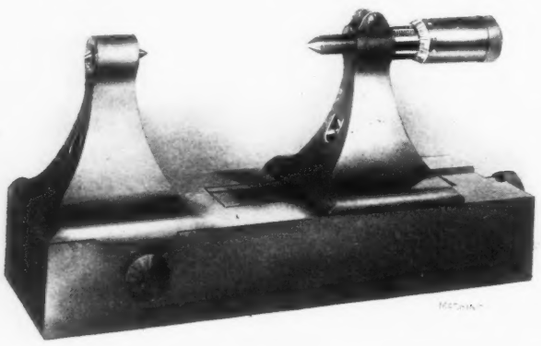


Fig. 3. Form of Device with Wide Range for General Manufacturing.

carrying the micrometer screw being arranged to clamp down at 1 inch intervals, and set to position by means of standard end gages placed between hardened steel plugs. As usually made, this style has a small size limit of 1½ inch diameter, with the upper limit at any reasonable point, as desired by the purchaser.

Wells Bros. Co. has issued a separate catalogue of gages, and has established a well-equipped department for the manufacture of these tools. This firm would be pleased to forward a copy of its gage catalogue on request.

* * *

The cost of fireproofing office buildings from 9 to 14 stories high, in our larger cities, has recently been the subject of an investigation, and the results have been published by the National Fireproofing Association. The figures show that, in general, the cost of the foundation and masonry work in such buildings is about one-third of the total cost. The steel frames cost about one-sixth, and the mechanical equipment and the furniture about one-fifth, the remaining part, or more than one-fourth, being expended for trim and finish. The experiences at Baltimore and San Francisco show that buildings of this kind in a conflagration may sustain damages in all respects excepting foundations and steel frames. As these two items represent a comparatively small percentage of the value of the building, the average fireproof building in a conflagration may easily sustain damage amounting to 70 per cent of its value.

INDUSTRIAL NOTES FROM EUROPE.

BRITISH TRADE TOPICS.

James Vose.*

The general aspect of industry in Great Britain points to a continuance of activity for some time to come. Considerable unrest, however, prevails among large bodies of workpeople in several industries. Engineers on the northeast coast are agitating for increased wages; in other parts the employment of the premium system is a cause of rupture, and in most districts resentment is still felt at the comprehensive scope of the conditions in the Engineering Trade Agreement, which makes for the security of employers. Railway employes of all grades are making efforts to improve their conditions as regards wages and hours. It is conceded that such a course is desirable, but the reduction in railway dividends likely to follow such concessions is considered excessive by the railway managements. However, it is hoped some slight benefit, at any rate, will be reaped by the men. A five per cent advance has been granted the cotton spinners, though weavers have been unsuccessful in their application. On the Continent, engineering labor is inclined to insist on advances in wages or reduction in the number of working hours, and, in certain branches, trade-union working conditions are being increasingly insisted on. In fact, the comparative docility, with which the Continental workman was often credited when labor topics were under discussion in other countries, is not now to be confidently counted upon. In Italy, in many instances, the somewhat sudden introduction of mechanical industries has upset the industrial equilibrium, and strikes or lockouts are frequent occurrences. The government, in order to assist the new industries, endeavors to discourage the emigration of labor to America. The utilization of hydro-electric power in Italy, which, it is realized, is a great national asset, is likely to cause considerable and beneficial economic changes in that tax-ridden country.

The spring and early summer has been cold and wet both in Great Britain and on the Continent, with quite marked effects on the automobile, cycle, and allied businesses. In these, the clothing, and other industries, effect has followed cause very rapidly, many being thrown out of employment or faced with considerable loss.

The Cargo Fleet Co. Steel Works.

In a previous article we mentioned the progress recently made in the equipment of a number of British iron and steel furnace plants and mills, and some particulars, as furnished to the Manchester Association of Engineers on a recent visit to the works of the Cargo Fleet Co., Ltd., Middlesboro, may be of interest. These works are situated about two miles from Middlesboro and consist of blast furnaces, with gas-driven blowing engines, coke ovens, steel furnaces, and rolling mills. The iron ore for the furnaces is obtained from the company's mines, about twenty miles away. The blast furnace plant consists of two furnaces, 90 feet high, with twelve Cowper stoves, each furnace capable of producing nearly 1,500 tons of pig iron per week, all of which is taken, molten, to the steel furnaces for conversion. There are seven Cockerill type gas blowing engines working on the single-acting Otto cycle, each engine delivering 14,000 cubic feet of free air per minute at a pressure up to 18 pounds per square inch. The cooling

* James Vose was born in Bolton, Lancashire, England, 1862. His education, other than that gained in common schools, was obtained by home study and in evening scientific schools. He served an apprenticeship in the repair shops of Geo. Hodgkinson & Son and Haslams, Ltd., both large cotton mills. He then worked as journeyman mechanic at Howarth Cryer & Co., Bolton; American Heald Co., Bolton; and Meldrum Bros., Ltd., Manchester, with which concerns he was a journeyman, foreman, and assistant superintendent; he was also in special charge of selection and use of all machine and allied tools and methods at Meldrum Bros., Ltd. He is now acting as consulting engineer on work-shop equipment. Mr. Vose has contributed to the trade press of Great Britain and the United States for several years. Address: 100 Ayres Road, Brooks Bar, Manchester, England.

water for the pistons and cylinder jackets is pumped by two electrically-driven pumps to the cooling tower. The gas for the blowing engines passes through three Theisen gas washers, two of which are capable of dealing with the gas from both the furnaces, amounting to about 20,000 cubic feet per minute. Each washer is driven by a 150 H. P. motor. Steam for two 1,000 H. P. turbo-generators and two Brown hoists by which the materials are automatically dumped into the furnaces, is furnished by nine water-tube boilers. Sixty tons of coal per hour is dealt with by the coal washing plant. The coke oven plant consists of 100 Kopper ovens fed by two double box coal compressors. The gas from the ovens passes to the by-product plant where sulphate of ammonia and tar are recovered. Sufficient gas is produced to supply 3,000 H. P. through gas engines.

The electric generating plant consists of a 350 K. W. compound steam direct-driven plant, two steam turbo-generators each of 750 K. W., two gas engines using coke-oven gas, each directly connected to 300 K. W. generators, and two gas engines using blast furnace gas, each directly connected to 375 K. W. generators. All the generators run in parallel at 220 volts continuous current. The steel smelting shop contains three 175 tons Talbot furnaces. The gas for these furnaces is supplied by ten mechanically stirred producers giving 150,000 cubic feet of gas per ton of coal. The furnaces are charged by an electrically-driven charging machine and two 40-ton overhead hot-metal cranes, while two 75-ton steel casting cranes are provided on the casting side of the furnaces. One 150-ton gas-fired mixer is installed.

Two rolling mills are at work. The cogging mill has 40-inch center of rolls, with 8 feet 6-inch rolls driven by a three-cylinder compound condensing engine, 45 x 52-inch. The finishing mill consists of four stands of rolls direct driven by an engine exactly similar to the cogging mill. The central condensing plant is capable of dealing with steam from three mill engines of the size already mentioned. The pump house is equipped with electrically-driven circulating pumps, steam-driven dry air pumps, condensor water pumps, steam-driven hydraulic pumps, and boiler feed pumps. The works are also provided with very extensive river frontage, and a wharf at which the products of the company can be loaded into deep-sea craft.

Factors Governing Selection of Special Tools.

It is often the case that tools introduced with a view of showing some working advantage over existing types may prove their claims within certain limits, but the increasing use of the new style does not preclude the simultaneous growth of the older ones. We may instance portable drilling machines, etc., driven electrically or by compressed air. The question of which class to select may easily be governed quite as much by the particular shop conditions as by the relative economy or efficiency of the drills themselves. In one shop compressed air may be used quite freely for a number of purposes, and electricity scarcely employed. The use of air-driven drills is thus governed by factors more or less apart from its merits as a tool. In the next shop, current may be universally available, while compressed air may not be called for, and the electrical drill is, of course, employed. In other shops both sources of power are at disposal, and it may be a convenience to have both types of drills in use, but that which is found to be the most economical in working cost is selected as the standard shop tool. Even then it may pay to retain the old rope-driven portable drill in some instances. We have been led to make the above comments by the fact that concerns formerly identified with the production of one particular type now offer both, without attempting to draw invidious comparisons, an attitude which might, with advantage, be more widely adopted.

Small Lathes.

Several firms over here make quite a specialty of small lathes, etc., worked by treadle or power. Drummond Bros., Ltd., Guildford, Surrey, are making a feature of such lathes with special reference to their employment for motor car repairing, etc. The saddles are arranged to act as boring carriages, if required, and generally the lathe is so designed as to adapt it to a wide range of duties, such as met with in repair shops. The owners of many large English country houses find it advisable to install such a tool for the use of their chauffeur or engineer, as the number of motor cars kept at, and the mechanical equipment of, such large houses is often quite extensive. Many cars being of Continental manufacture, the lathes mentioned are arranged to cut metric as well as ordinary screw threads. These tools being produced in large quantities, are sold at remarkably low prices, considering the good work put into them. We hope later to give some further particulars of these lathes.

Amateurs' Lathes.

G. Birch, Salford, Manchester, has for many years devoted special attention to the production of amateur lathes made to suit customers' individual requirements. The class of users for whom these tools are made does not so much consider price as all round adaptability and accuracy. They are used for experimental work of a precisional nature by scientists. Others are used by wealthy men simply as a hobby, many of these users turning out beautiful specimens of medallion work by profiling methods, in ivory, ebony, etc. Some of the work done is perhaps scarcely to be classed as turning, as the lathes are equipped also to act as milling and drilling machines, slotters, shapers, etc., in fact they become practically complete machine shops in themselves. We were recently informed of such a lathe which was forwarded to an almost inaccessible part of India for the purpose of providing congenial occupation during the leisure hours of a military officer of high rank. It has been remarked that probably only good would result if such a class of users could be created among the many extremely wealthy men found in the United States.

JAMES VOSE.

Manchester, England, June 29, 1907.

MISCELLANEOUS FOREIGN NOTES.

BRITISH EXPORTS OF MACHINERY.—The year 1906 marks a record in British exports of machinery, and to those who regard foreign trade as an index of prosperity, the present state of the British machine building trade is the best possible. The total value of exported machinery was approximately $130,000,000. This figure is more than 50 per cent larger than that of five years ago, and more than 25 per cent larger than in 1904. The increase from the previous year was 15 per cent.

BRITISH INDUSTRIAL COMBINATIONS.—Ever since the formation of the steel trust in this country, amalgamations have been the order of the day, even in Europe, the latest instance of this movement being the joint working agreement between the Belfast firm of Harland & Wolff and John Brown & Co. of Clydebank and Sheffield. If the report referred to by the London *Times* is correct, this combination will be the most important amalgamation that has ever taken place in the shipbuilding world.

TRADE CONDITIONS IN AUSTRIA.—Consular reports from Austria indicate that during the year 1906 there was an unusual industrial activity throughout the country. The output in the most important industries increased from 10 to 20 per cent as compared with the previous year, and factories were enlarged in numerous cases. Wages increased about 10 per cent and the general prosperity of the country was greater than ever. The only drawback was the increased cost of raw materials, as well as the higher cost of living.

MACHINE TOOL TRADE IN HOLLAND.—A report by Consul F. D. Hill, Amsterdam, states that American machine tools are subjected to a keen German competition in Holland on account of the fact that American tools are, relatively, priced somewhat higher than German tools sold in that country. The actual price charged for the best tools made in Europe is about the same as the price of American tools, but the Germans, in general, use harder material for their machines, which insures longer life. Mr. Hill states that the packing of American machine tools is considered very good and much better than that of European tools, a thing that is gratifying in view of so many consular complaints of late in regard to poor packing of American merchandise in general. The gen-

eral complaint of slow and delayed delivery is, however, as prominent in this report as in almost all other reports by our consuls in Europe.

THE AUTOMOBILE INDUSTRY IN EUROPE.—A French statistician, Mr. Faroux, estimates that in 1906 there were 55,000 automobiles built in France, 28,000 in Great Britain, 22,000 in Germany, 19,000 in Italy, and 12,000 in Belgium. Until a year ago France led the world in the production of motor vehicles, but during the last year the United States has taken the lead, the number of motor cars manufactured in this country being estimated at 60,000 in 1906. In 1901 the United States built only 314 cars, and France in the same year 23,711. It is said that in all 550,000 cars have been manufactured since the experiment with self-propelled vehicles succeeded, and these cars have been sold for a sum exceeding $1,000,000,000, or for a price averaging about $2,000 a car. Many of the present European cars, however, sell for considerably less than $1,000, the average price of German automobiles being $1,080 in 1906.

THE PRESENT PROSPECT OF MACHINE TOOL BUILDING IN GERMANY.—According to reports from Germany, the conditions in the machine tool trade appear to be steadily improving. Many works report that it is quite impossible for them to take any new orders for delivery during 1907. There has been some anxiety that the continually increased price of machine tools would be harmful, but it has been found that the customer is more concerned about the period of delivery than about the increase of prices. However, although the machine tool builders' product commands a higher price, it is not probable that this will bring any higher profits, inasmuch as the rise in raw material has been proportionally as great as the increase in the selling price of the finished product. It is not likely that German machine tool builders will increase their plants to any great extent at the present time, but rather wait until there will be a less general prosperity, and a possibility offered of making additions at cheaper rates than could now be done.

GERMAN MANUFACTURERS COPY AMERICAN TRUST METHODS.—Consul-General Richard Guenther, of Frankfort, writes that scarcely a day passes but the German newspapers report a new trust or syndicate in some line of German manufacturing. The causes assigned for these centralization movements are the increased cost of materials, the greater demands of employes, and the losses brought about by injudicious competition among manufacturers and dealers. The object aimed at is to protect and promote the interests of the individual members of the trade. In the pursuing of this aim, however, the restrictions established cannot but cause a reaction in the trade, inasmuch as the rise of prices may be followed by a decrease in demand or a limitation of output. One of the important amalgamations at the present time is the bicycle trust. The keen competition in this trade has brought down prices to a very low level, and leading bicycle firms, wanting to keep prices up, have concluded that the only possibility for doing so is syndicate work.

ERNST SCHIESS, WERKZEUGMASCHINENFABRIK A. G., Düsseldorf, Germany, has brought out some new machine tools, two of which are of particular interest. One is a cylinder boring machine, designed for boring cylinders up to 9 feet in diameter and intended for high speed cutting tools. This machine consists of a head and tail-stock mounted on a heavy base plate, the center of the spindle being 5 feet 4 inches above the base plate. The machine is driven by a 15-horse-power motor. The boring bar has an automatic feed varying from 0.020 to 0.600 inch per revolution. The revolutions of the spindle range between 0.54 and 3.6 per minute. The maximum boring length is 10 feet. The other machine mentioned is a horizontal boring and shaping machine, consisting of a bed with a movable column placed upon it, on which is mounted the counterbalanced head-stock. This machine is driven by a 12- or 15-horse-power motor. The diameter of the boring spindle is 7 inches, the length of the boring feed is 5 feet 4 inches, the vertical traverse of the head-stock is 10 feet, and the horizontal traverse of the column, 20 feet. The revolutions vary from 10 to 110 per minute.

THE CONDITION OF GERMANY'S AND GREAT BRITAIN'S FOREIGN TRADE.—Consul Thos. S. Norton, of Chemnitz, reports that while the German foreign trade has been comparatively small in regard to machinery during the past year, the German machine industry is in an exceptionally flourishing state, and the falling off in exports simply proves that the demands of the home market are so immense as to require all the attention of the machine builders. The inability of Germany, as well as of the United States, to supply the world's market with machine tools to the full amount of the demand has been very favorable to Great Britain, the foreign trade of which has in regard to machine tools been much greater during the last year than ever before. There have often been expressed optimistic views in England on account of this fact, but one of their leading technical journals calls attention to the fact that while the past year has been exceedingly prosperous, England may nevertheless meet with difficulties, when the high tide of prosperity recedes in Germany and in the United States, because these two countries will then bring their competition to play against Great Britain more severely than they are able to do at the present time, and is warning English machine tool builders from expecting too much of the future.

* * *

OPENING OF KEUFFEL & ESSER CO.'S NEW FACTORY.

The formal opening of the new factory buildings of the Keuffel & Esser Co., in Hoboken, N. J., took place on July 20, in the presence of the officers and employes of the company, and many invited guests. The new buildings, which will be devoted exclusively to the manufacture of the company's well-known products of engineers' and draftsmen's supplies, consist of two very handsome reinforced concrete constructions, one five and the other six stories high, and represent, without exaggeration, the latest progress in factory design. They are entirely fireproof, even the window sashes being made of metal, and provided with wire glass. When open, the windows are fastened on fusible links, so as to close automatically in case of fire. Besides, there is an extensive system of automatic fire sprinklers.

One of the new buildings is primarily intended for offices and storerooms, and the general offices, hitherto located at 127 Fulton St., New York, will in the future be located here, the building in New York being retained only as a general store, and for showrooms.

The opening of the new factory also marks the forty years' anniversary of the establishment of the firm of Keuffel & Esser, the business of the firm having been started July 19, 1867, by William Keuffel and Hermann Esser. In commemoration of this as well, the company had invited all its employes to take part in the opening exercises, and afterward gave a luncheon and entertainment on one of the floors in the new building for its force, amounting to upward of 700 persons.

* * *

PERSONAL.

Will Mr. William C. Terry please send his present address? Mail addressed to him at Boston, Mass., was not delivered.

R. E. Fox, Jr., has resigned his position as manager of the New York office of the Platt Iron Works Co. to become secretary and manager of the sales department of the Engineer Company, New York.

Maurice Gesundheit and Henry Osgood have united under the firm name of Gesundheit, Osgood Co., with offices at 43 Cedar Street, New York, as manufacturing engineers and business methodizers.

The many friends of Mr. P. E. Montanus, the president of the Springfield Machine Tool Company of Springfield, Ohio, and secretary of the National Machine Tool Builders' Association, will hear with regret of the sudden death of Mrs. Montanus, which occurred last month. This estimable lady was greatly esteemed in Springfield, where she had spent many years of her life, and where she had been prominent socially and in charitable work.

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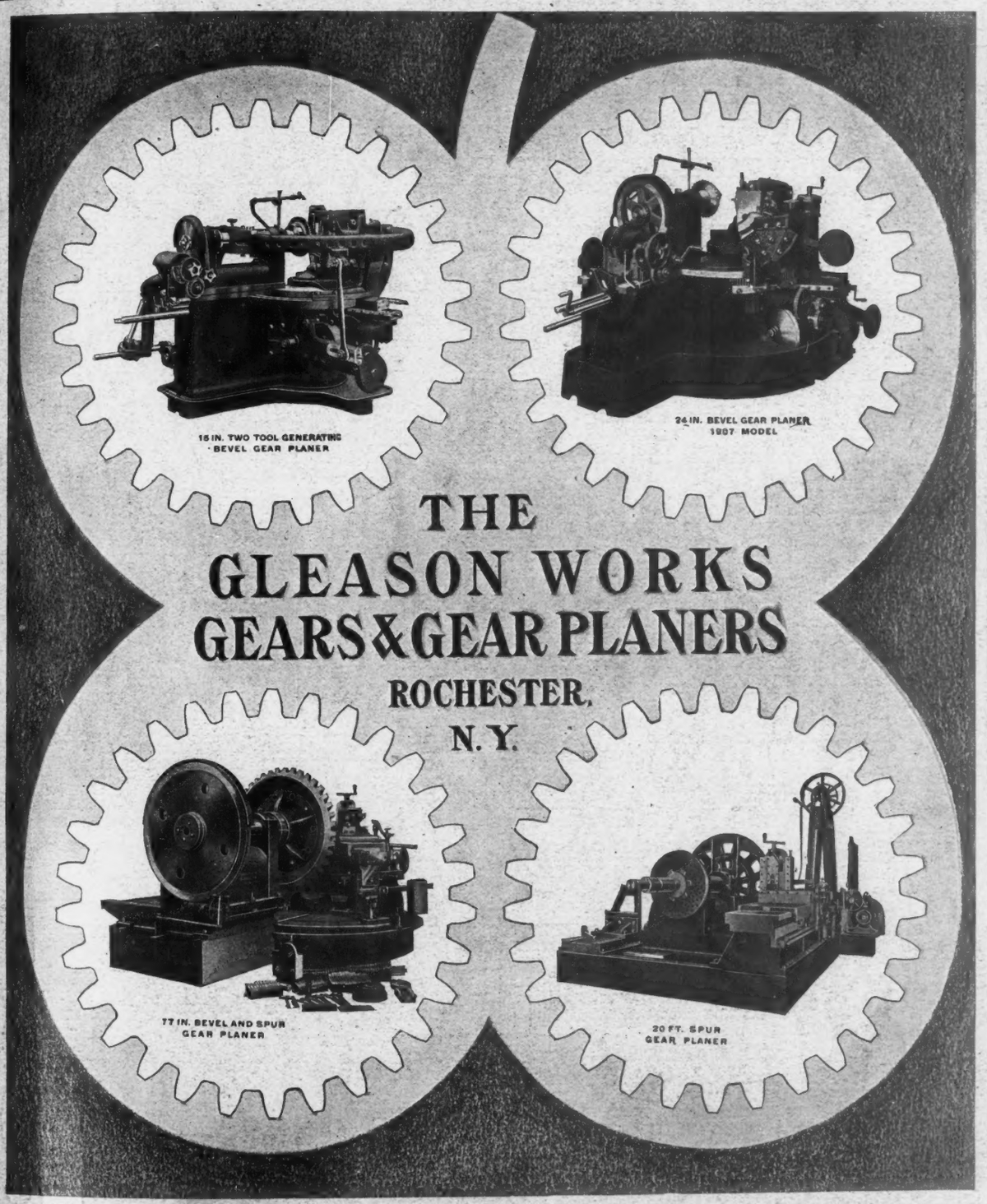
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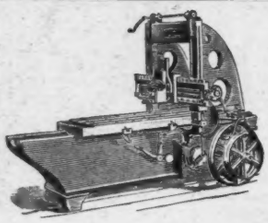

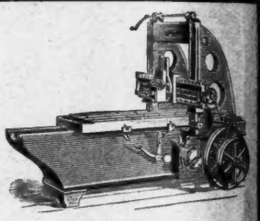

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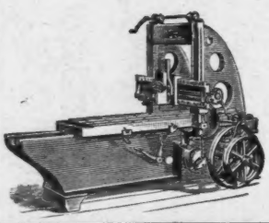

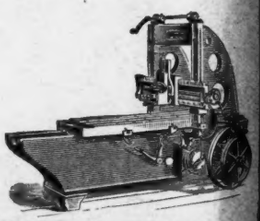

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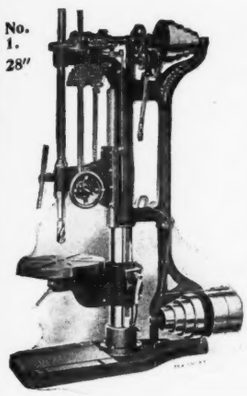

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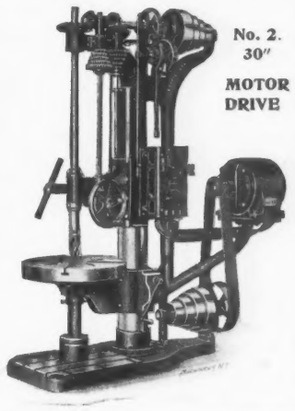

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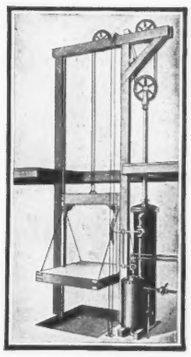

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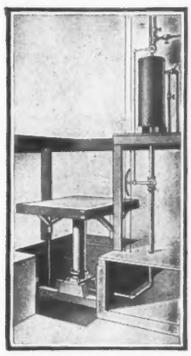

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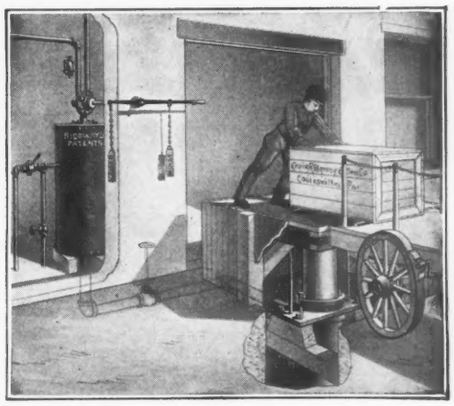

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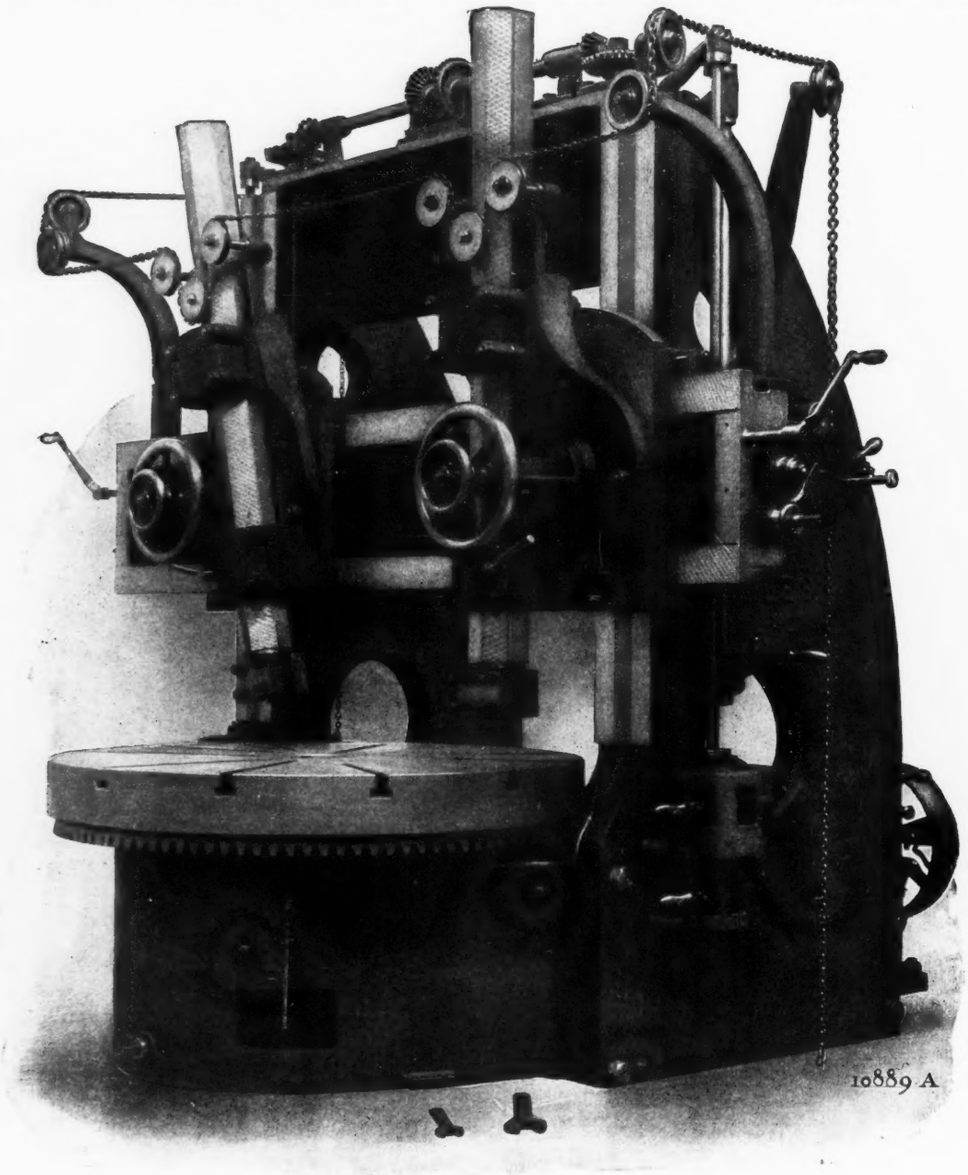

New 60' Niles Boring and Turning Mill, Single Pulley Drive. Sixteen Changes of Speed. Readily Convertible to Motor Drive.

The single pulley drive (wide belt at high speed) makes full power of machine available at every speed.

With motor drive, motor is direct connected through speed box, no belts whatever.

NILES-BEMENT-POND CO.

TRINITY BUILDING, 111 BROADWAY, NEW YORK

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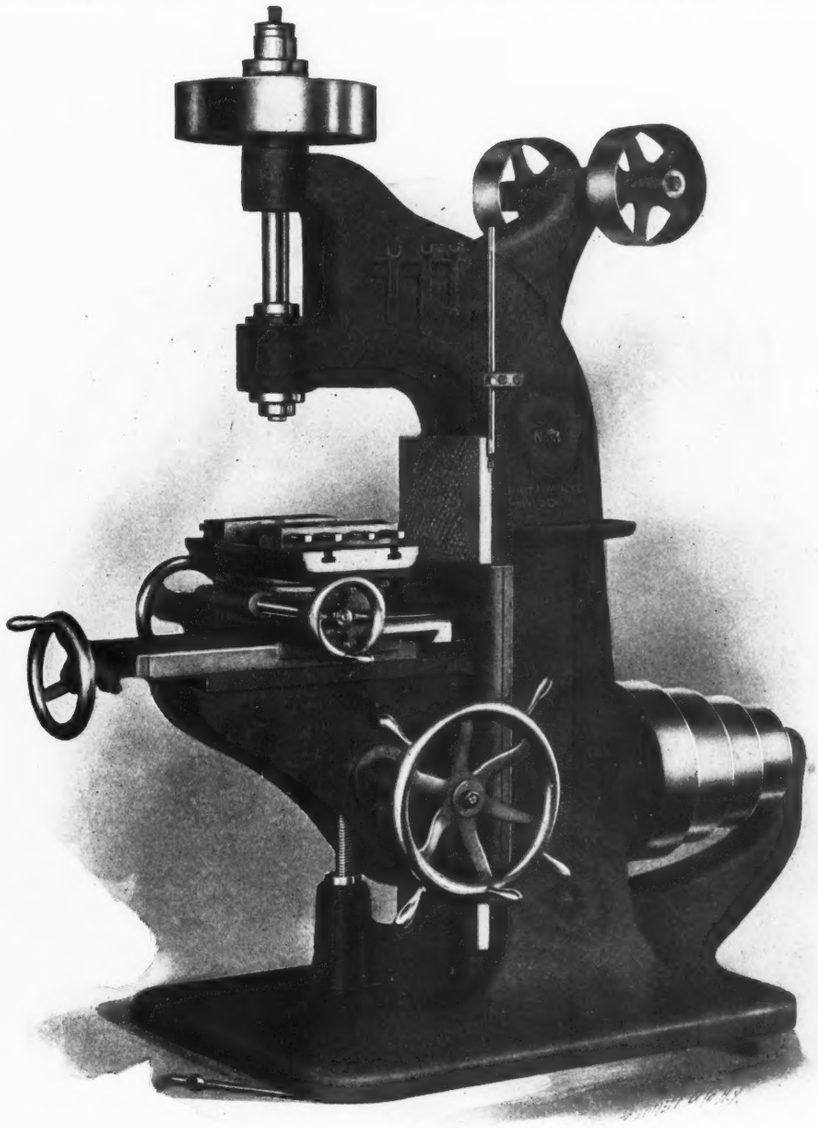
PRECISION TOOLS AND SMALL TOOLS

No. 3 DIE SINKERS **FOR IMMEDIATE DELIVERY**

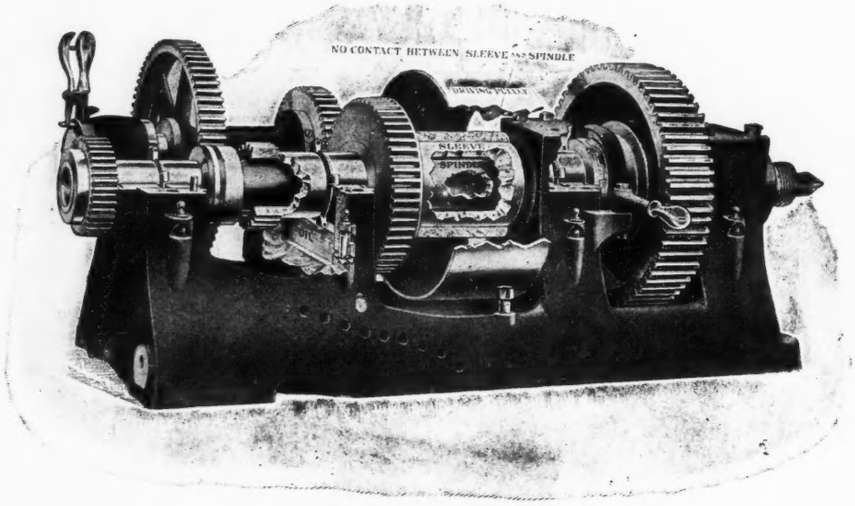


Pratt & Whitney No. 3 Die Sinking Machine. Built in two sizes.

For recessing dies for drop-press work or for forming and finishing recesses of circular or irregular shapes, these machines are particularly adapted. The work is held in a vise which has cross, longitudinal, vertical and rotary movement by hand wheels. The work may be guided by either a pattern or forming piece, or be controlled wholly by the operator. The spindle is driven by a belt which insures the smooth running of the cutter. These machines are very strongly built insuring smooth work.

PRATT & WHITNEY CO., Hartford, Conn., U.S.A.

Offices—**New York, 111 Broadway.** Boston, Oliver Bldg. Philadelphia, 21st and Callowhill Sts. Pittsburg, Pa., Frick Bldg. **Chicago,** Commercial National Bank Bldg. **St. Louis, Mo.,** 516 No. 3d St. Birmingham, Ala., Brown-Marx Bldg. **Agents for Canada,** The Canadian Fairbanks Co., Ltd., Montreal, Toronto, Winnipeg and Vancouver. London, E. C., Buck & Hickman, Ltd., 2 and 4 Whitechapel Road. London, S. W., Niles-Bement-Pond Co., 23-25 Victoria St. Copenhagen, Denmark, V. Lowener. Stockholm, Sweden, Aktiebolaget V. Lowener. Paris, Fenwick Freres & Co., 8 Rue de Rocroy, Agents for France, Belgium and Switzerland. Japan, F. W. Horne, 70-C Yokohama. Italy, Stussi & Zweifel, 8 Via Dante, Milan.



PATENT HEADSTOCK

If you were buying a lathe to turn or bore 10-inch diameter work of any length, would you buy an 18-inch Engine Lathe?

Or to put it differently—

How often do you turn or bore a 5-inch diameter and under, to one of 10-inch and over on an 18-inch lathe, in the run of your shop work?

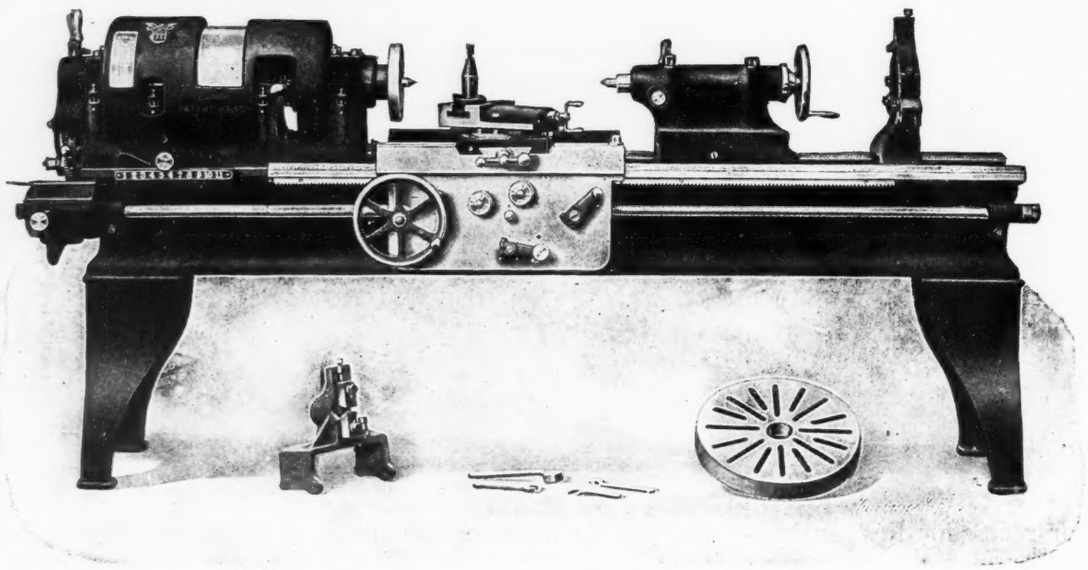
The answer to that question is the reason for the Patent Head.

If then, the average 18-inch is but a 5-inch machine for most work, why not better means for handling such work cheaply?

Open belt speeds that have power, not simply filing speeds.

Back geared speeds that give a proper surface speed upon small diameters.

It is because the Patent Head meets these conditions more successfully than the Cone Pulley Lathe—because of its broad belt (to carry open belt cuts), big diameter pulley (to give great contact) and a broad belt running over a big diameter pulley (great power for all cuts), because it offers back gear speeds up to 110 r.p.m, of spindle—that it is worthy of a place in your shop.



18-inch Screw Cutting Lathe with Patent Head Drive, **4½-inch Belt over 12-inch diameter Driving Pulley,** six open belt speeds, six 3:1 back gear speeds, six 9:1 back gear speeds. Automatically oiled spindle, sleeve, and back gear bearings. 32 thread and feed changes without taking off or putting on a gear.

Lodge & Shipley Machine Tool Company

Cincinnati, Ohio, U. S. A.

CANADIAN AGENTS—H. W. Petrie, Toronto, Ont. EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Paris, Brussels, Barcelona, Milan. C. W. Burton, Griffiths & Co., London. V. Lowener, Copenhagen, Stockholm, Christiania. R. S. Stokvis & Zonen, Rotterdam. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg. Werner Hult, Helsingfors, Finland. OTHER AGENTS - Bevans & Edwards, Melbourne, Australia. Richardson & Blair, Wellington, New Zealand. Adolfo B. Horn, Havana. W. F. McKenzie, Mexico City. Andrews & George, Yokohama.

BETTS MACHINE COMPANY

WILMINGTON, DEL., U. S. A.

Makers of

Heavy Machine Tools

For High Speed Steel

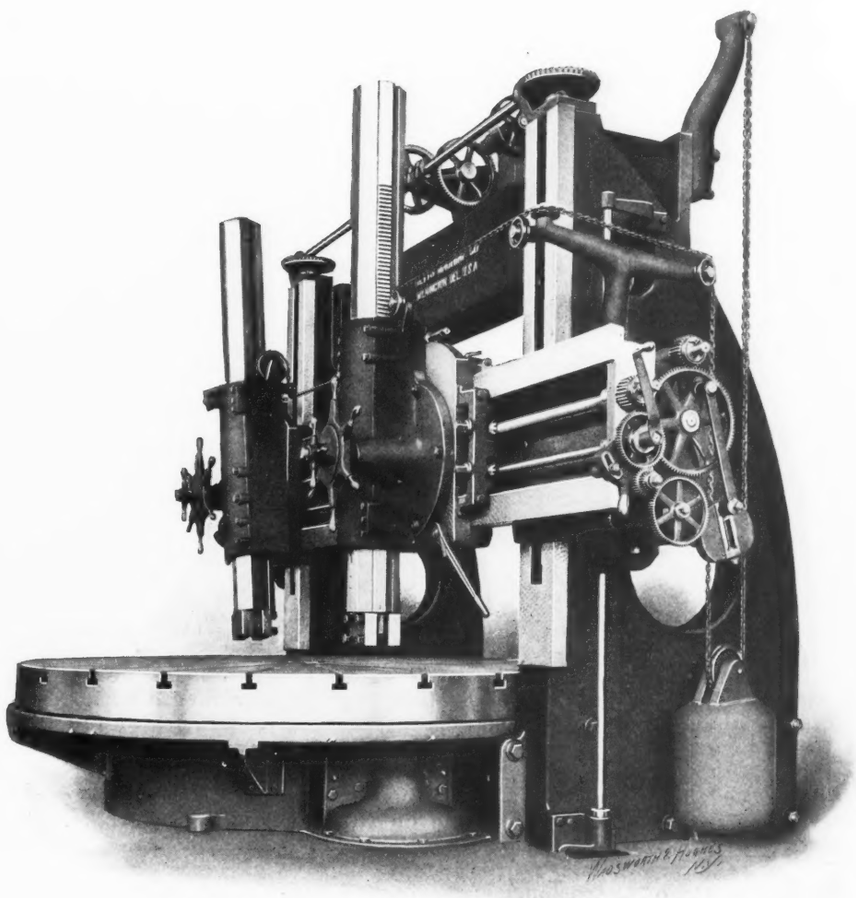
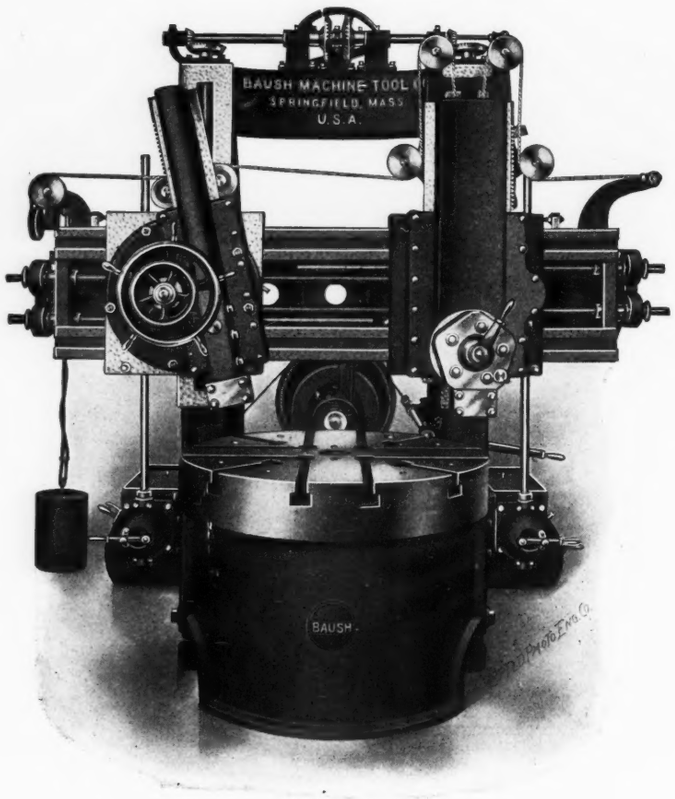


Illustration shows the BETTS Motor-Driven Extra Heavy Double Drive 10 ft. Boring and Turning Mill, as made for the General Electric Company's Works at Lynn and Schenectady.

Vertical Boring Mills — Planers, Slotters,
Horizontal Boring Machines, Floor Borers, Etc.

A Rigid and Powerful Boring and Turning Mill for Heavy Work



THE BAUSH 42-INCH BORING AND TURNING MILL takes a prominent place among heavy machines of this type and can be counted on for first-class work in quick time. It is built with one swivel head and one turret head—each entirely independent in its movements both as to direction and amount of feed; either can be brought to the center for boring, and both have a vertical movement of 24 inches. Rigidity of the spindle and table is secured by straight and angular bearings, which, acting in conjunction, relieve the side strains. Any lifting tendency of the table is further counteracted by a thurst ball bearing on the lower step of spindle. Feeds are positive and have 15 changes ranging from $\frac{1}{64}''$ to $\frac{61}{64}''$ horizontally and $\frac{1}{64}''$ to $\frac{9}{64}''$ in angular and vertical directions. All improvements contributing to ease and rapidity of operation, safety and economical production are incorporated in the design of this machine.

Furnished with two regular swivel heads if desired. Belt or motor drive.

Full particulars will be furnished by the makers.

BAUSH MACHINE TOOL COMPANY

SPRINGFIELD, MASS., U. S. A.

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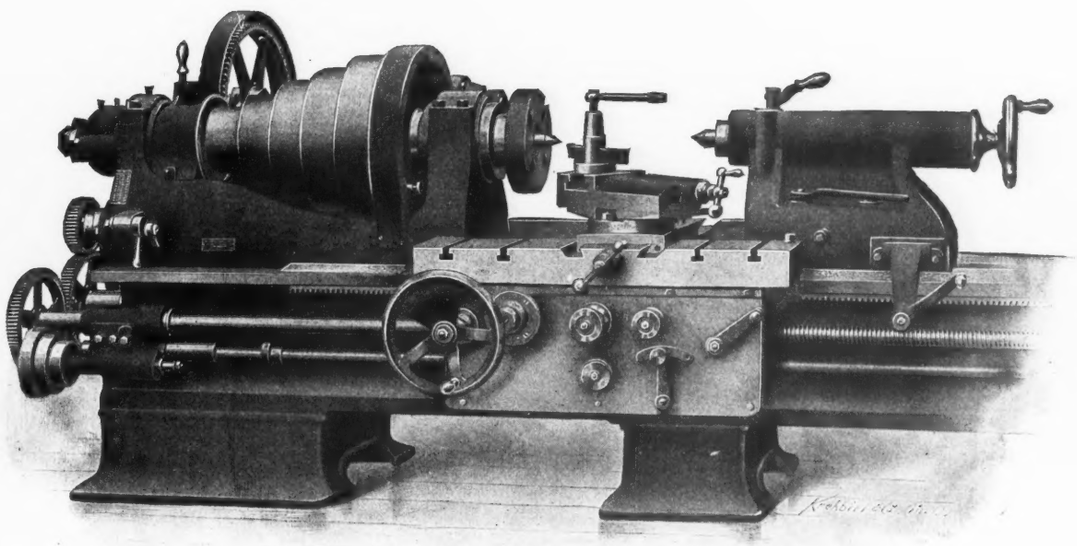
32-inch Bradford Lathe



Bradford Construction

is another way of expressing high-class workmanship, finest materials and best design. Every convenience for rapid and easy operation is included in the make-up of Bradford Lathes; they have the power and rigidity to stand the strain of severe service and high speeds, and are up-to-date in every detail.

The 32-inch machine is typical of the Bradford line—heavy, strongly built with a liberal amount of metal properly distributed. Sliding surfaces are scraped, journals and studs are made of high carbon steel, accurately ground, spindles are of hammered crucible steel with hole bored from solid stock. Spindle bearings are of gun metal of the taper pattern, with provision for taking up wear. This Lathe has a wide range of feeds—power cross feed graduated to read in thousandths—double apron with non-interfering feed reverse—automatic stop.

Catalogue shows sizes from 14" to 42" swing.

The Bradford Machine Tool Co.

CINCINNATI, OHIO, U. S. A.

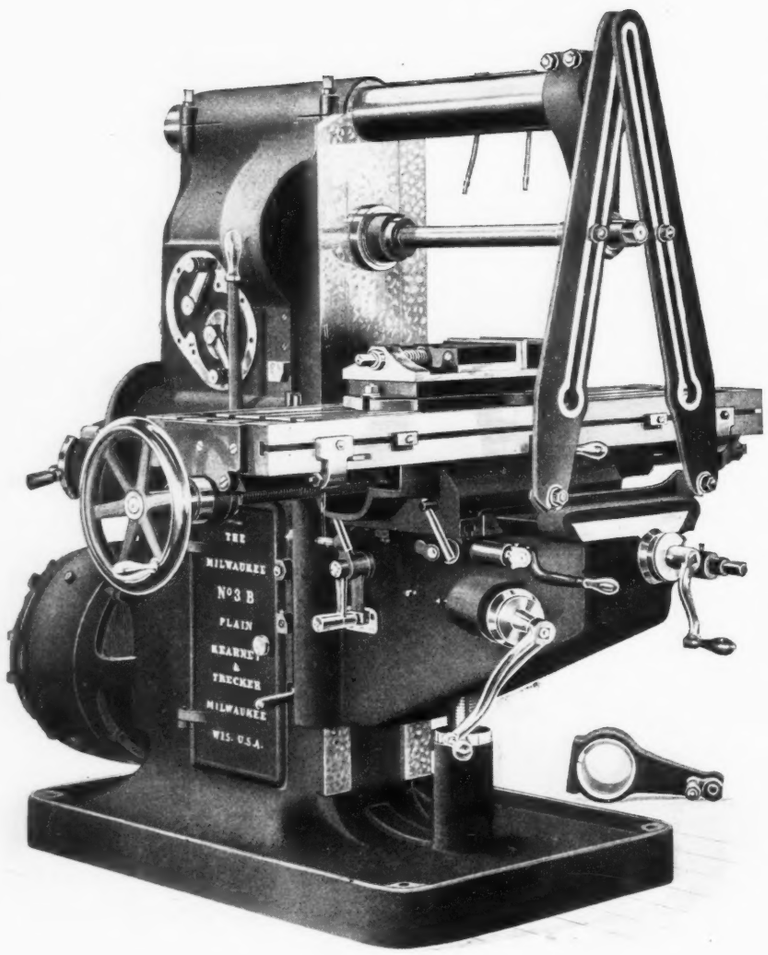
AGENTS—Vandyck Churchill Co., New York and Philadelphia, Eastern Agents. Pacific Tool and Supply Co., San Francisco, Cal., Agents for Pacific Coast. F. W. Horne, Yokohama, Agent for Japan, China and the Far East. Chas. Churchill & Co., Ltd., London, Birmingham, Glasgow, Newcastle-on-Tyne. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona.

SOME DAY
SOME CONDITION
SOME WHERE

in your shop will demand an electric driven Miller. When that time comes you will be in luck if you have a

Milwaukee Heavy Duty

belt driven machine, for all that will be necessary to make it look like these cuts will be to remove the pulley bracket and bolt the motor in its place. All done in half an hour as easily as changing from gloves to mittens, and you will have a compact, direct connected unit, the best there is to be had.



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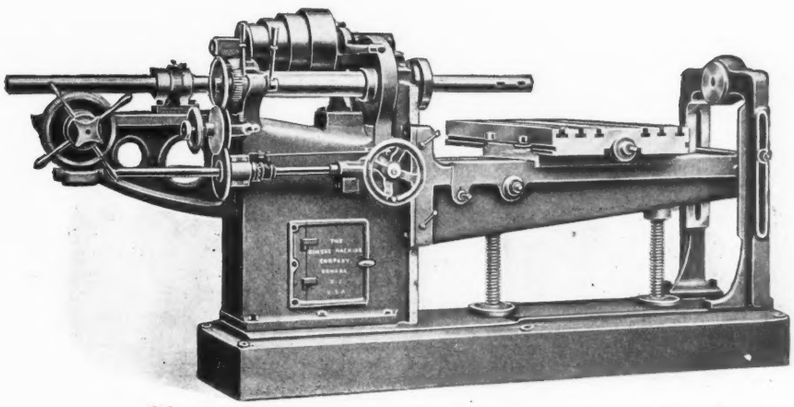
A RAPID WORKER

FOR

ACCURATE BORING



No. 3 Machine

Moreover, we arrange this tool for aluminum cases especially. You should see this machine make the chips fly.

PROMPT DELIVERY

The Binsse Machine Company

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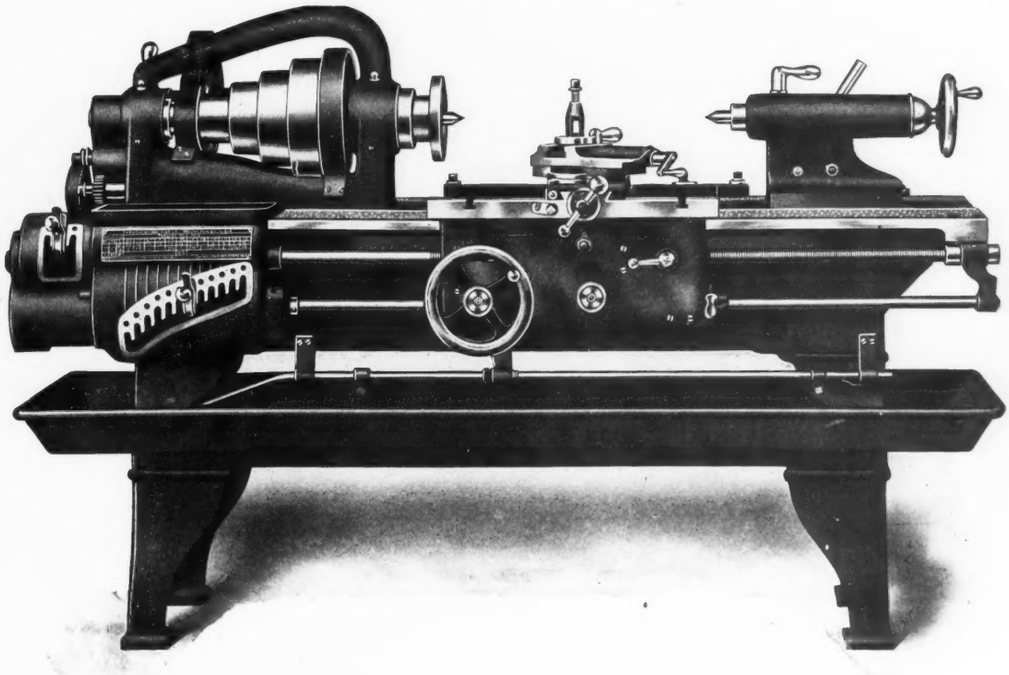
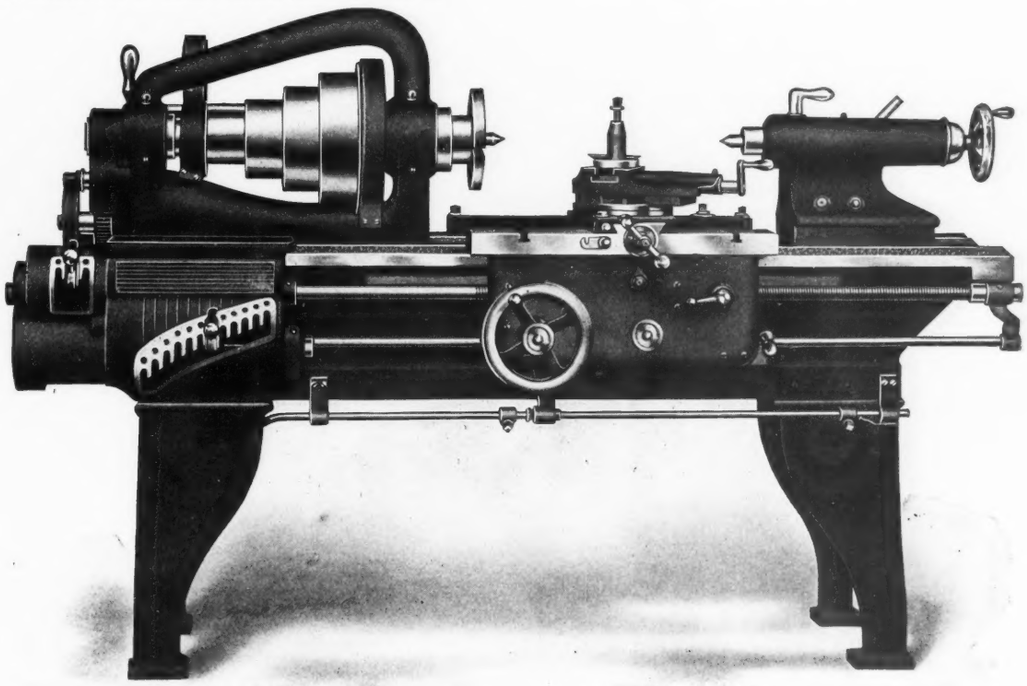
Hendey-Norton Patent Improved Screw Cutting Engine Lathes



Have the simplest and most efficient quick change gear equipment: unlimited in its range. Have Automatic Stop for carriage travel in either direction. Have feed and thread reverse operated from apron: does away with reversing the whole lathe in cutting threads, and allows 16 spindle speeds from two-speed countershaft. All lathe heads excepting on 32 in. swing have tie-bar construction, taper journals on spindle, ring-oiling, annular bearings: longest lived, easiest running lathe head made Manufactured in 12 in. to 32 in. swing; 4 ft. to 24 ft. beds, and fitted with all regular attachments as desired.

Fully illustrated in Lathe Catalogue. Send for it.



The Hendey Machine Co., Torrington, Conn., U.S.A.

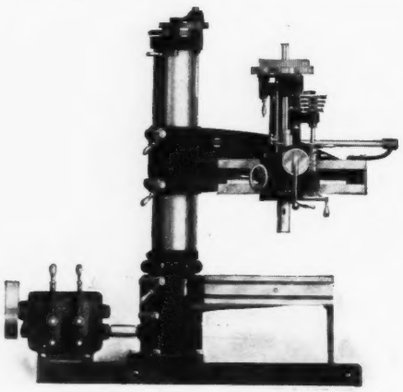
AGENTS IN AMERICA—Manning, Maxwell & Moore, Inc., New York, Boston, Philadelphia, Pittsburg and Chicago. Syracuse Supply Co., Ltd., Syracuse, N. Y. Pacific Tool and Supply Co., San Francisco. W. M. Pattison Machinery Co., Cleveland. R. V. Whitacre & Co., St. Paul, Minn. J. W. Wright & Co., St. Louis. Smith-Courtney Co., Richmond, Va. W. P. Davis Machine Co., Rochester, N. Y. J. L. Osgood, Buffalo. Strong, Carlisle & Hammond Co., Detroit, Mich. Robert Gardner & Son, Montreal, Canada. A. R. Williams Mchy. Co., Toronto, Canada. EUROPEAN AGENTS—Chas. Churchill & Co., London, for Great Britain. Stussi & Zweifel. Milan for Italy. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. A. H. Schutte, Cologne Brussels, Paris, Milano, Barcelona. Takata & Co., Tokio, for Japan.

DO YOU REALIZE

The Great Saving in Drilling Time Possible Thru the Use of Modern High-Power

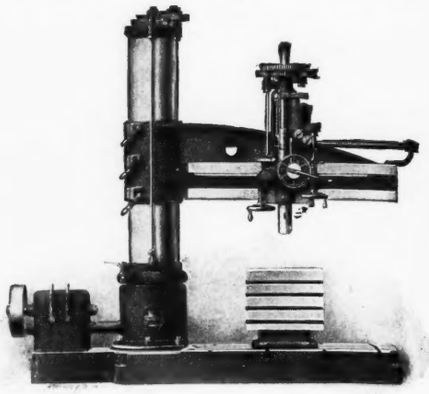
RADIAL DRILLS?

This is particularly true where the smaller size Radials replace the larger size Uprights



Plain: 2½ ft.—3 ft.—3½ ft. arm

Cone Pulley, Speed Box or Motor Drive.

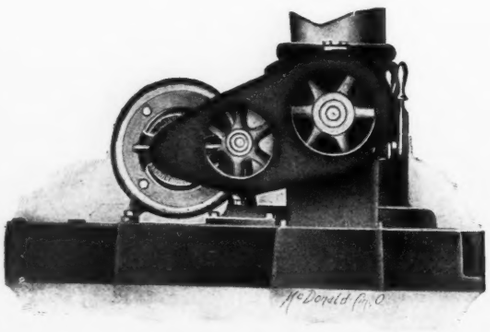


Plain: 4 ft —5 ft.—6 ft.—7 ft. arm.

"AMERICAN" RADIALS

are noted for their enormous power, scientific construction, accuracy, rigidity and ease of manipulation.

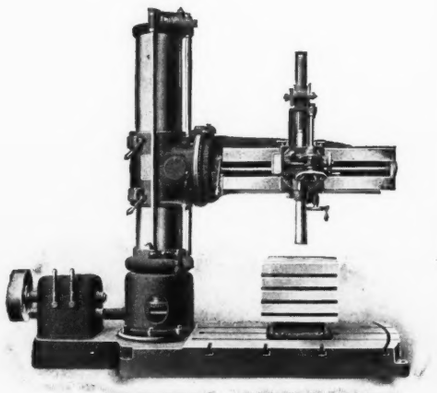
THEY ARE THE TOOLS BEST SUITED FOR YOUR WORK.



Motor Driven Thru Speed Box.

Positive Geared Feeds.

Catalog "K" Now Ready.



Full Universal: 5 ft.—6 ft.—7 ft. arm,

MANY A GOOD DOLLAR IS SAVED

by stopping the bad leaks in the drilling department.

It's a matter worthy of your serious consideration if you are trying to widen the gap between

ACTUAL COST AND SELLING PRICE.

THE AMERICAN TOOL WORKS COMPANY,

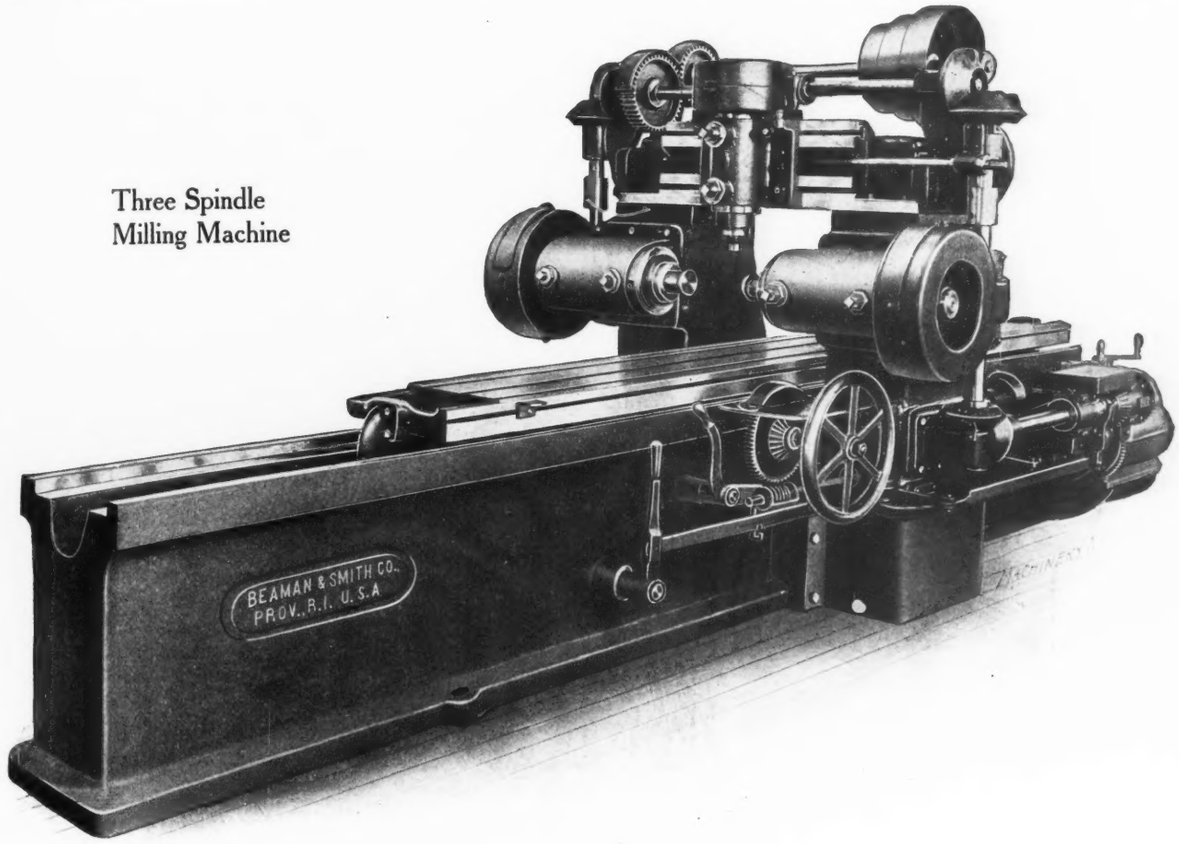
300-350 Culvert St., Cincinnati, Ohio, U. S. A.

LATHES
PLANERS

NOTICE—To receive new catalogue when issued, machine tool users please send postal with company's name and mechanical officer in charge.

SHAPERS
RADIAL DRILLS

Three Spindle
Milling Machine



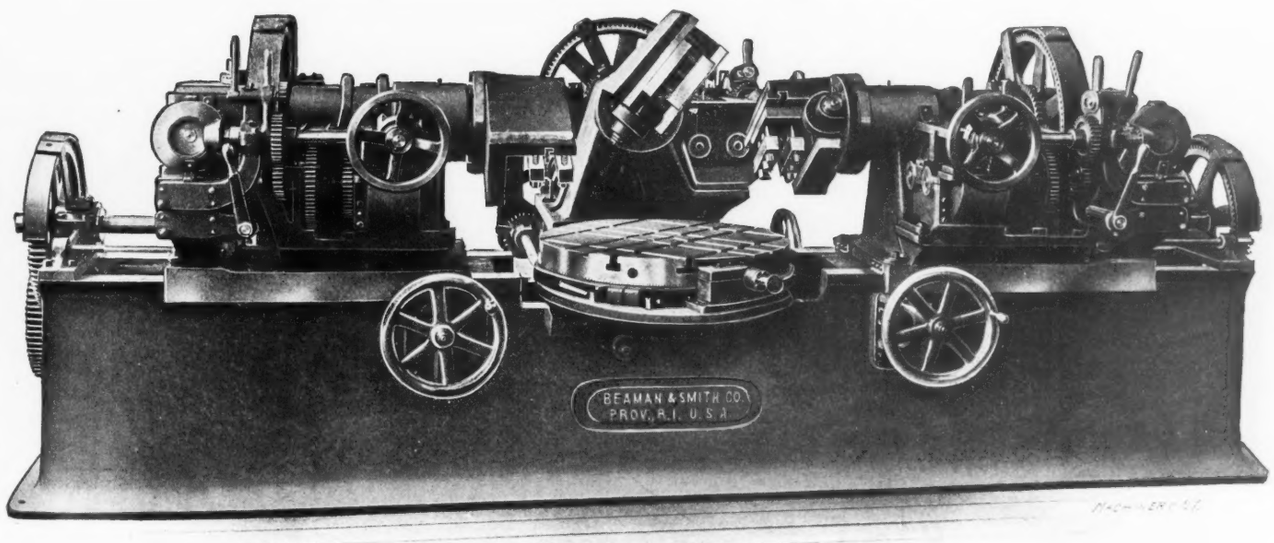
WE MAKE A SPECIALTY OF SPECIAL MACHINES

Boring and Milling Machines in Particular

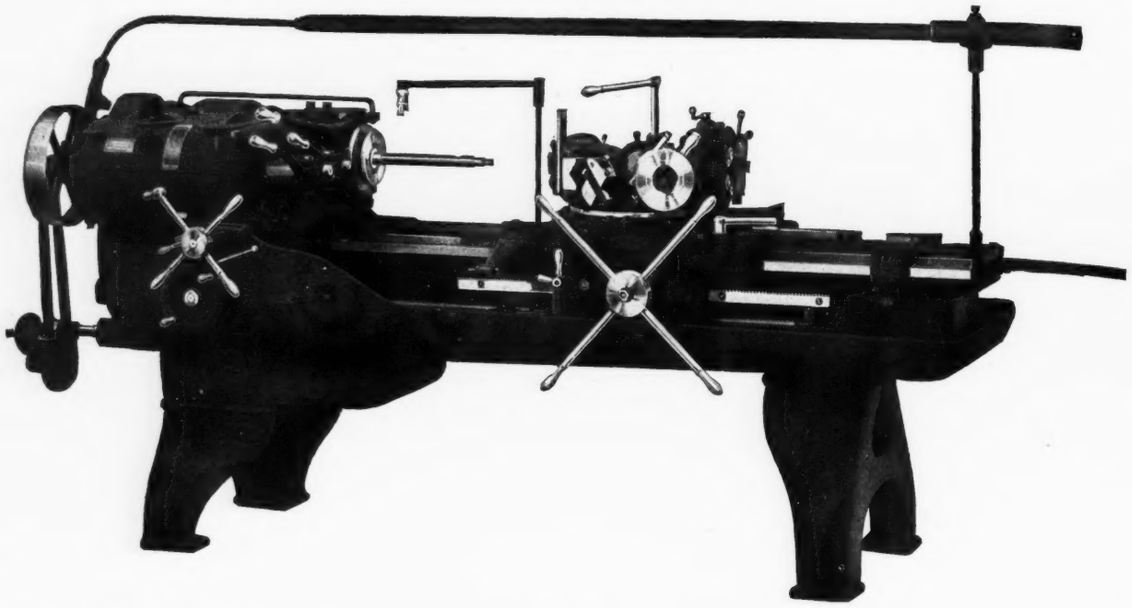
Write us your needs.

The Beaman & Smith Company, Providence, R. I., U.S.A.

AGENTS: Berlin, Ludw. Loewe & Co.; Paris, Fenwick Freres & Co. London, Chas. Churchill & Co.



Machine for Facing Three Surfaces Simultaneously.



A DAILY DEMONSTRATION

of the economy of modern equipment is to be had in every shop where a Jones & Lamson Flat Turret Lathe has been installed. It is not only a case of quicker work, but more accurate work, and less trouble to produce it. Duplicate lathe work within its range, either from the bar or chucked, can be turned out on

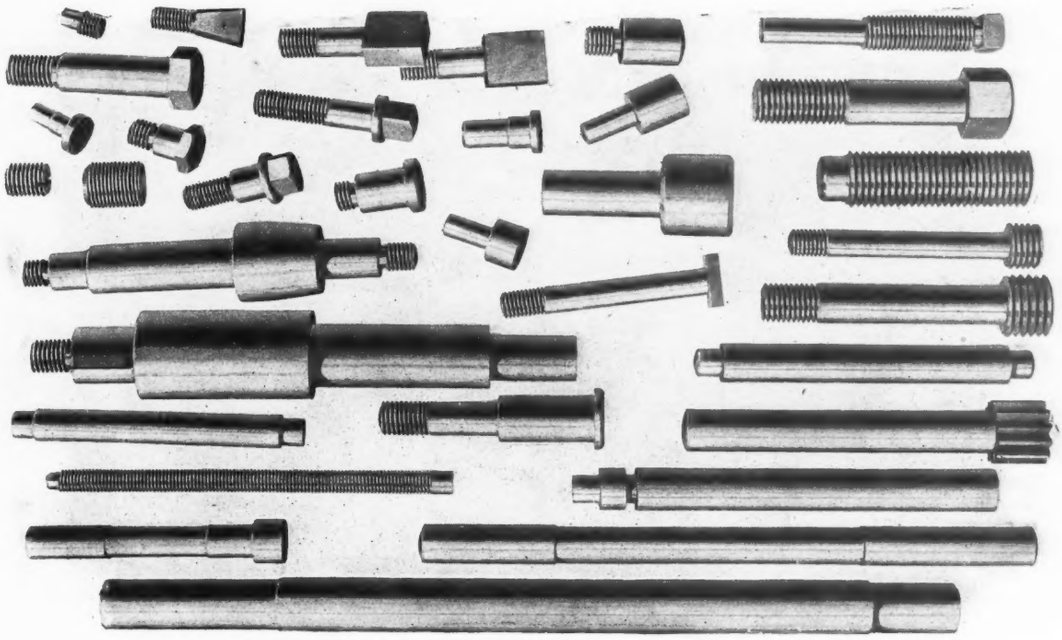
The Flat Turret Lathe

at a saving that varies from 50 to 80 per cent. over the engine lathe, or ordinary turret lathe, and in small lots at that. Another advantage is the universal equipment of tools that permits ready changing from one style of work to another. There is no delay, no waiting for special tools—you can fulfill your promises if you have a Flat Turret Lathe to back you up. One of our representatives will be in your vicinity this month—would it interest you to have him estimate just how great the economy would be in your special line? This will place you under no obligation—it is *his* particular work to look into the cost cutting end of *your* work. Just mail a card with your address.

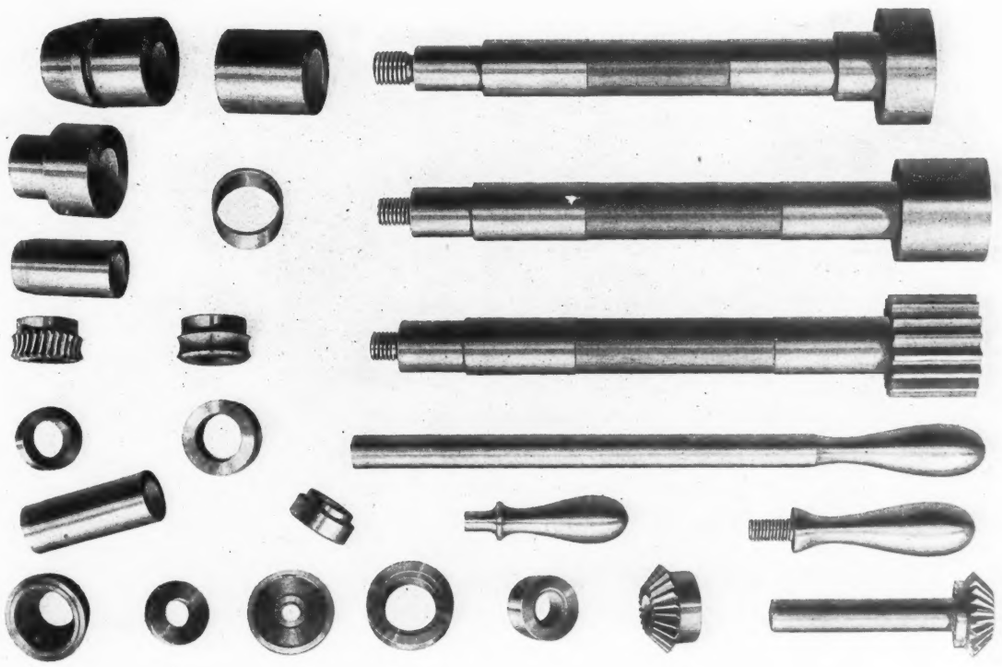
Jones & Lamson Machine Company

Springfield, Vermont, U.S.A. **Queen Victoria St., London, E. C.**

Germany, Holland, Belgium, Switzerland, Austria-Hungary, M. Koyemann, Charlottenstrasse, 112 Dusseldorf, Germany.
France and Spain, Ph. Bonvillain and E. Ronceray, 9 and 11 Rue des Envierges, Paris. Italy, Adler & Eisenschitz, Milan.

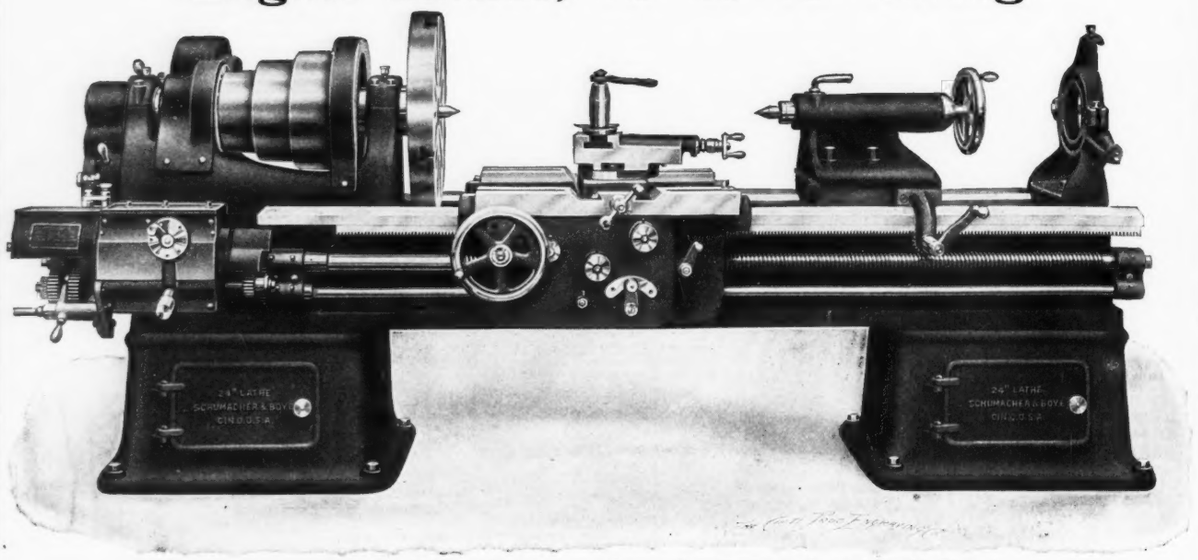


A FEW examples of work from the bar turned out by the Flat Turret Lathe with Cross Sliding Head, Single Drive, Variable Speed device and other improved features of construction that distinguish the new model machines. Two sizes, 2 x 24 and 3 x 36. Capacity for bar work up to 24″ and 36″ in length, and chuck work of all kinds up to 14″ diameter.



SCHUMACHER & BOYE

Engine Lathes, 18" to 48" Swing



Twenty-four inch Double Back Geared Instantaneous Change Gear Engine Lathe with Double Plate Apron.

SCHUMACHER & BOYE

CINCINNATI, OHIO, U. S. A.

P. H. Bonvillian and E. Ronceray, 9 and 11 Rue des Envierges, Paris, France. Ludwig Loewe & Co., Huttenstrasse 17-20, Berlin, Germany. Buck & Hickman, Ltd., 2 and 4 Whitechapel Road, London, E. C., England. Takata & Co., Japan.

The D. & H. Open Side Planer

The patented (No. 472804—1892) feature of a *Right Angle Cross Beam* with a downwardly projecting leg, and the Side Head mounted thereon, gave to THE OPEN SIDE PLANER its *rigidity*, and made it the efficient and valuable tool it is today.

The Detrick & Harvey Machine Company

Manufacturers of

The Open Side Iron Planers, Horizontal Drilling, Boring and Milling Machines, Threading and Tapping Machinery, Special Machinery

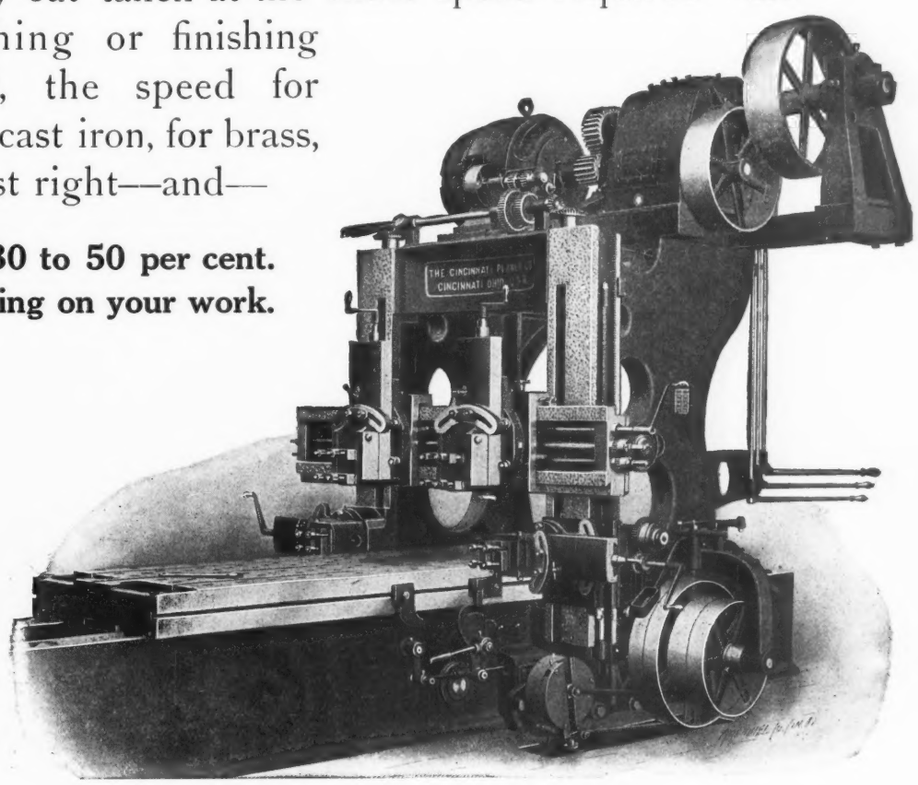
Baltimore, Maryland, U. S. A.

FOREIGN REPRESENTATIVES—Charles Churchill & Co., London, Eng. Ludwig Loewe & Co., Berlin Germany. Ing. Vaghi, Accornero & Co., Milan, Italy.

We'll be glad to "show you" the advantages of a Cincinnati Variable Speed Planer at our Cincinnati plant—or you can look the machine over at the establishment of any of our agents.

There's a lot in it for the up-to-date manufacturer to consider:—
Four or six speeds at your command, ranging from 15 to 60 feet per minute.
Constant return of table.
Power for the heaviest work.
Every facility for easy handling.
Every cut taken at the exact speed required—the roughing or finishing speed, the speed for steel, cast iron, for brass, all just right—and—

A 30 to 50 per cent. saving on your work.



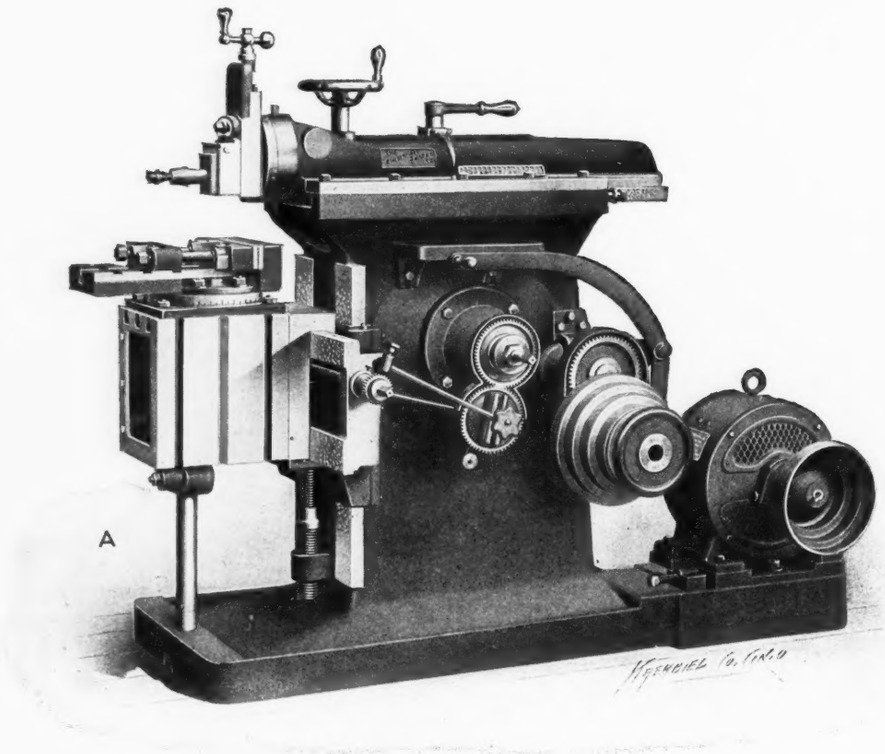
Send for new catalogue if a call is out of the question.

THE CINCINNATI PLANER COMPANY

CINCINNATI, OHIO, U. S. A.

DOMESTIC AGENTS—Prentiss Tool and Supply Co., New York, Boston and Buffalo. Marshall & Huschart Mchy. Co., Chicago. Motch & Merryweather Mchy. Co., Cleveland, Ohio. W. E. Shipley, Philadelphia, Pa. Baird Mchy. Co., Pittsburg, Pa. W. R. Colcord Mchy. Co., St. Louis, Mo. Scott Supply and Tool Co., Denver, Col. Harron, Rickard & McCone, San Francisco and Los Angeles, Cal. Hallidie Mchy. Co., Seattle. Cotton States Belting and Supply Co., Atlanta. The Fairbanks Co., Baltimore. Vonnegut Hardware Co., Indianapolis. Robinson & Cary Co., St. Paul. Zimmerman, Wells & Brown, Portland, Oregon FOREIGN AGENTS- Ludw. Loewe & Co., Berlin and Paris. R. S. Stokvis & Zonen, Rotterdam, Holland. J. Lambercier & Co., Geneva, Switzerland. Vaghi, Accornero & Co., Milan.

CINCINNATI SHAPER WITH MOTOR DRIVE



The Application of Motor Drive to Cincinnati High Duty Shapers

Has been given the same careful attention that characterizes every detail of construction in these machines. Our Form A, as shown in engraving, is fairly representative, and illustrates a 16″ Back Geared Crank Shaper with constant speed motor, four step cone, belt drive, brake for stopping the machine, and extended base for the accomodation of motor. The economy and convenience of individual motor drive for machine tools was long since acknowledged, and added to the general efficiency of Cincinnati Shapers insures ideal conditions for work.

Cincinnati Shapers are the most powerful shapers of their stroke on the market. The ratio of back gearing is very high, cone pulleys of large size, the ram is of approved form with wide and long bearing in the column, and the rail unusually strong and heavy. Especially adapted for high speed steels.

Write for Catalogue E.

The Cincinnati Shaper Co., Cincinnati, Ohio

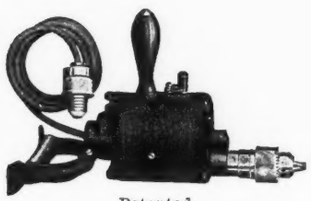
AGENTS—Manning, Maxwell & Moore, Inc., New York, Chicago, Boston, St. Louis, Cleveland, Detroit, Birmingham. Syracuse. Brown & Zortman Machinery Co., Pittsburg. W. E. Shipley, Philadelphia. The National Supply Co., Toledo, O. Bailey-Smith Machinery Co., San Francisco, Cal. L. Booth & Sons, Los Angeles, Cal. Robinson & Carey Co., St. Paul, Minn. Zimmerman-Wells-Brown Co., Portland, Ore. Hallidie Machinery Co., Seattle, Wash Cotton States Belting and Supply Co., Atlanta, Ga. A. Warden & Co., London, E. C. A. H. Schutte, Brussels, Cologne, Liege, Milan, Bilbao, Paris. Schuchardt & Schutte, St. Petersburg, Vienna, Berlin, Stockholm. H. W. Petrie, Toronto, Montreal.

NOTHING SUCCEEDS LIKE SUCCESS

WE NOW MAKE

Our Portable Electrical Drills up to 2" capacity.
Our Portable Electrical Grinders up to 2 H.P.

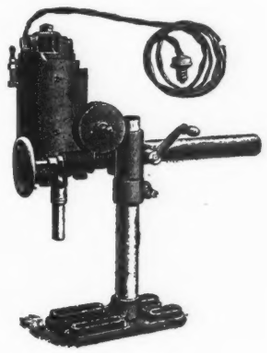
We made up a few of the above larger size tools to oblige several of our customers and they proved satisfactory in every way. We have not been advertising them, as we can only turn out a limited number on account of the continued rush orders on our smaller tools. Let us book your order today. We will send any of our machines on trial. Return if not satisfactory.



Patented

The "Hisey" Portable Electrical Hand or Breast Drill.

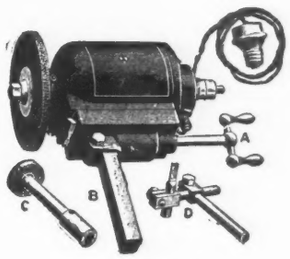
6 sizes, ¼", 3/8", ½", ¾", 7/8", 1¼" capacities. Weights, 8 to 38 lbs., respectively. Chuck arranged for close corner drilling. Speed can be changed while running. Extra side handle for use as breast drill. Mechanically cooled. Screw feed for larger size drills.



Patented

Portable Electrical Scotch Radial Drill.

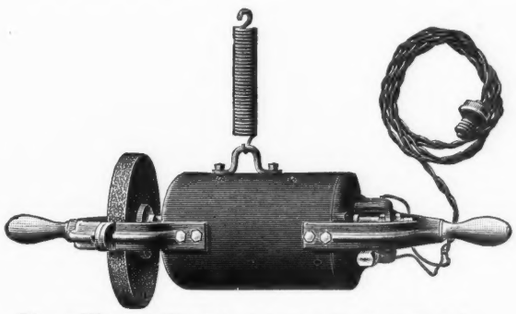
Made in 3 sizes of 7/8" and 1¼" and 2" in steel. 12' hand-feed, with quick return by hand. 24" Radius. Motor set at any angle. Drill in any direction. Does away with carrying heavy work to the drill press.



Patented

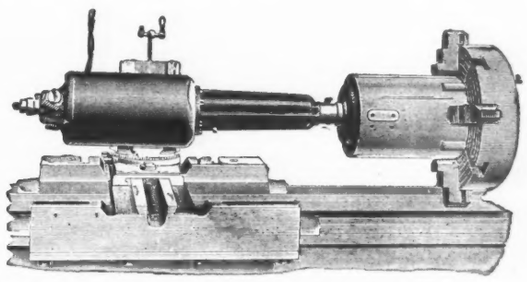
The "Hisey" Portable Electric Tool Post Grinder.

For Grinding Centres, Cutters, Reamers, Dies, Rolls and Internal and Surface Grinding Set in Tool Post of Lathe, Planer or Milling Machine. 4 sizes of ¼, ½, 1 and 2 H.P. 3 styles.



The "Hisey" Electrical Aerial Surface Grinder.

This grinder was particularly devised for rough surface grinding and the cleaning of castings of any kind. It also does away with hand filing and chipping. Can be suspended anywhere. Wheel handle adjustable vertically. ½, 1 and 2 H.P.



The "Hisey" Electrical Internal Grinder.

Bolted on Tool-rest of Lathe.

Especially designed for grinding and finishing up gas, steam and air cylinders, grinding out hardened dies, trueing up bearings and internal cylindrical grinding of any kind. Extensions made 12", 20", 35", as required. Vertical adjustment.

Bench Grinders--Hand Grinders--Motor with Flexible Shaft.

POWER FROM ANY LAMP SOCKET. DIRECT OR ALTERNATING CURRENT.

Largest Builders of Portable Electrical Tools in the World.

OUR CATALOGUE No. 5-M ILLUSTRATES FULLY.

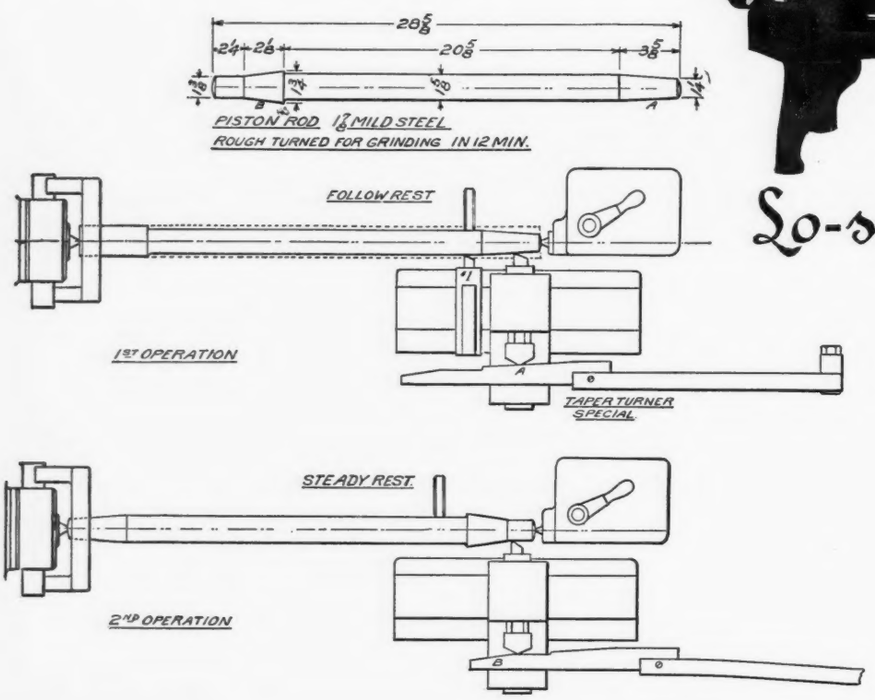
The Hisey-Wolf Machine Co.

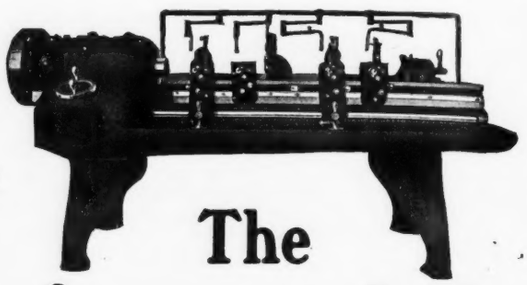
CINCINNATI, OHIO

New York Office: 150 Nassau Street

IN STOCK BY FOREIGN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, St. Petersburg, Vienna, Stockholm. Alfred H. Schutte, Cologne, Paris, Brussels, Bilbao, Milan, Liege. J. Lambercier & Co., Geneva, Switzerland.

Arrangement of tools turning **Straight** and **Taper** shaft simultaneously.





The Lo-swing Lathe

Lo-Swing is for **Turning.** Several tools may be in **Simultaneous** operation.

That means **Production.**

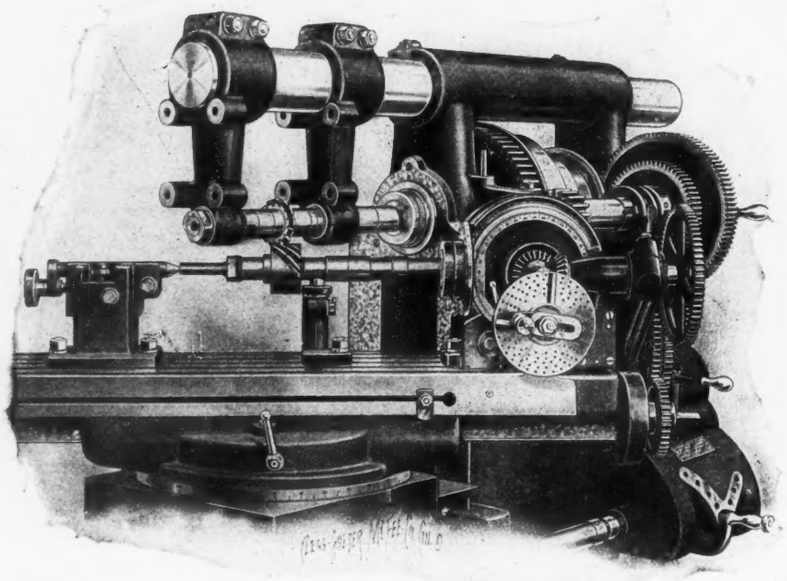
Go over this illustration carefully.

Send us blue prints of **your** work.

FITCHBURG MACHINE WORKS, FITCHBURG, MASS., U. S. A.

FOREIGN AGENTS—P. & W. Maclellan, Ltd., Glasgow. Henry Kelley & Co., Manchester. Alfred H. Schutte, Brussels, Liege, Paris, Bilbao, Barcelona, Portugal. M. Koyemann, Dusseldorf, Germany, Holland, Switzerland. Schuchardt & Schutte, Vienna. Adler & Eisenschitz, Milan.

The Original Double Friction Back Geared Miller



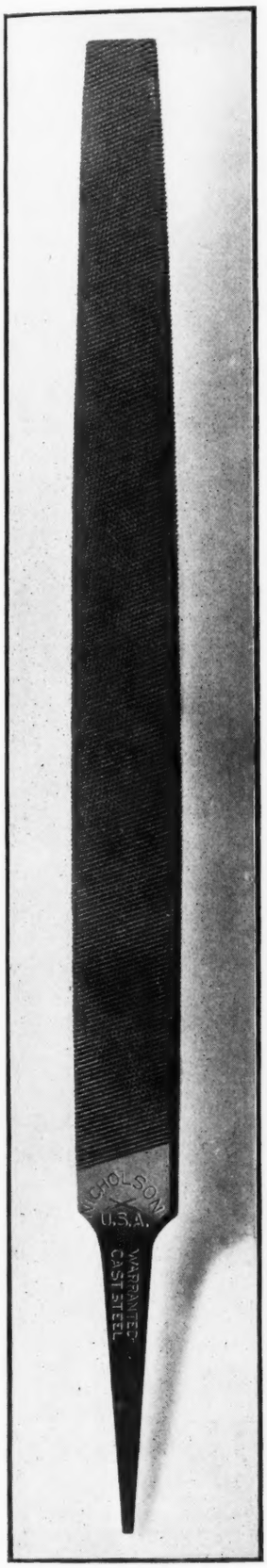
One of the many operations of which the LeBlond Machines are capable.

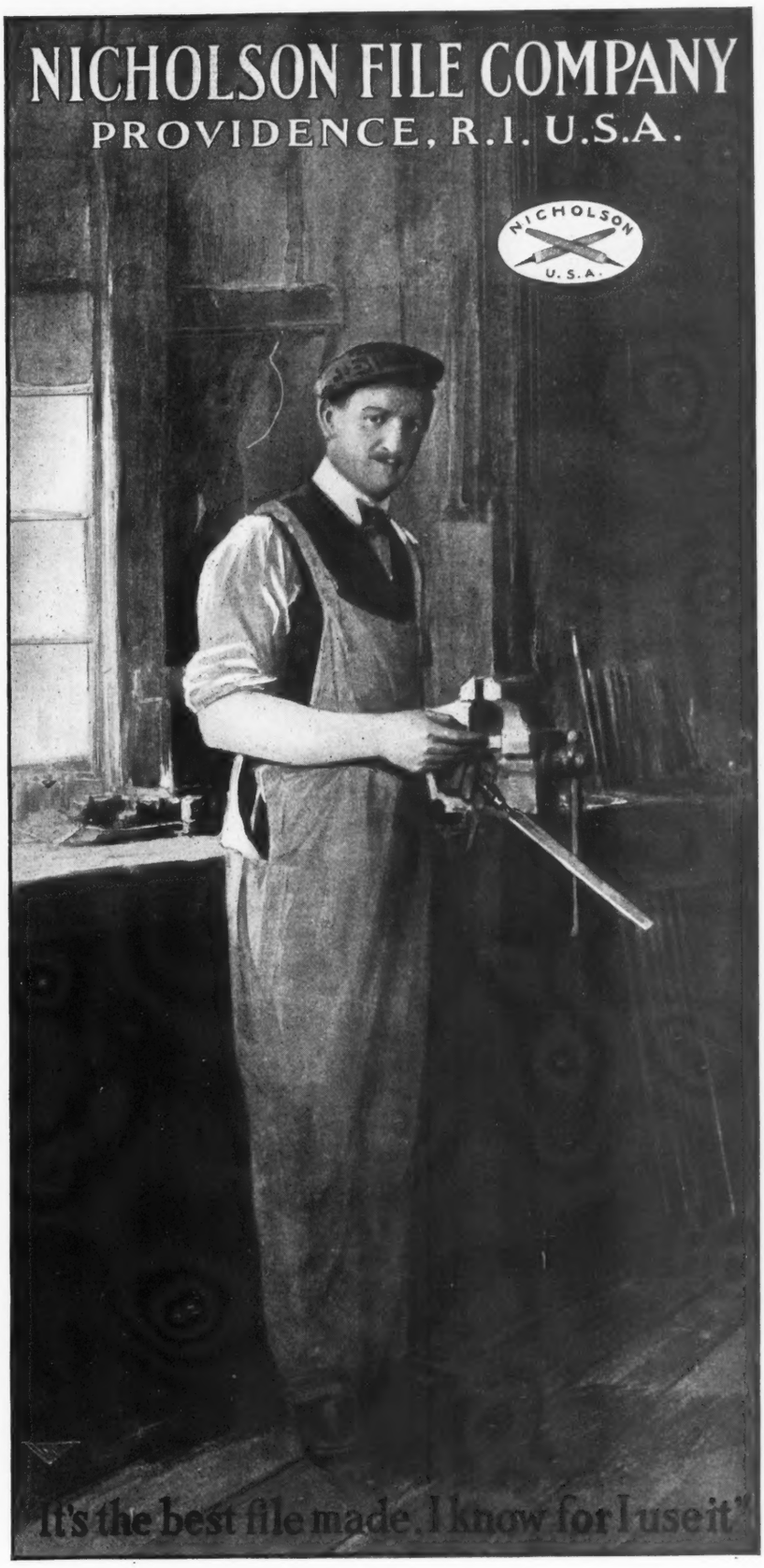
This shows our No. 3 Universal Miller cutting 6 pitch spiral cast iron gears. Table angle is 50 degrees. Feed 4 inches per minute. This is accomplished without noise, vibration or chatter of any kind. Can you do as well with your machine?

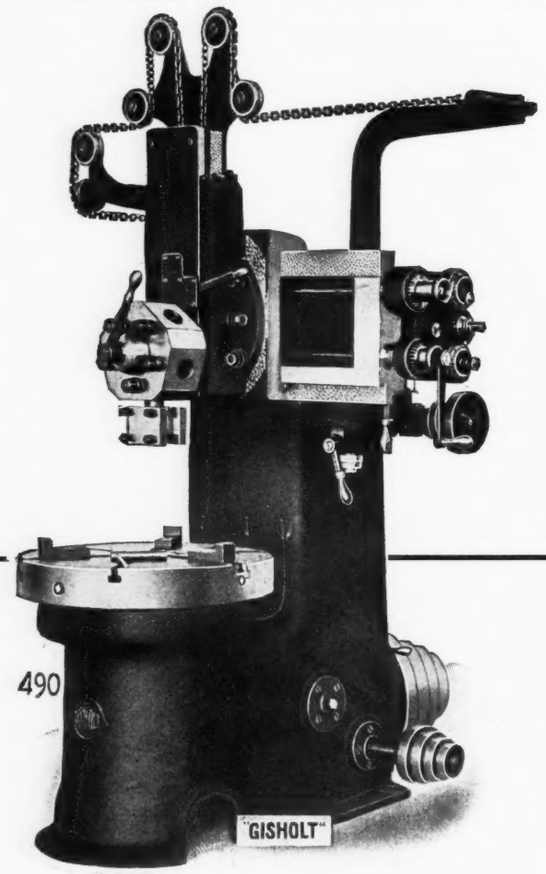
Write us for booklet showing advantages of our double friction back geared millers.

The R. K. LeBlond Machine Tool Co., 4605 Eastern Avenue, Cincinnati, Ohio

AGENTS: Germany, De Fries & Cie., Akt. Ges., Dusseldorf, Berlin, Stuttgart. Italy, De Fries e. C., Corso Prinzipe Umberto, Angolo Via Moscova, Milano. France, De Fries & Cie, 19 rue de Rocroy, Paris. Belgium, De Fries & Cie, 36 rue Fosse aux Loups, Brussels. Spain, De Fries y Cia., 660 Calle de las Cortes, Barcelona.


NICHOLSON
U.S.A.
WARRANTED
CAST STEEL


NICHOLSON FILE COMPANY
PROVIDENCE, R.I. U.S.A.
NICHOLSON
U.S.A.
"It's the best file made. I know for I use it"



Gisholt 30" Vertical Boring Mill

Quick Deliveries ON Small Boring Mills

As we have been devoting our Warren, Pa., plant exclusively to the manufacture of 30" and 36" Vertical Boring and Turning Mills and have been gradually increasing our capacity, we are in a position to name quick delivery on a limited number of the 30" mills.

The 30" mill has an extreme swing of 34" and a height under the rail of 17½". The 36" mill swings 36½" and has a height under rail of 18½". Both machines equipped with most modern devices for quick and accurate handling of work. Full details forwarded on application.

Gisholt Machine Company

General Offices, 1316 Washington Ave., Madison, Wis.

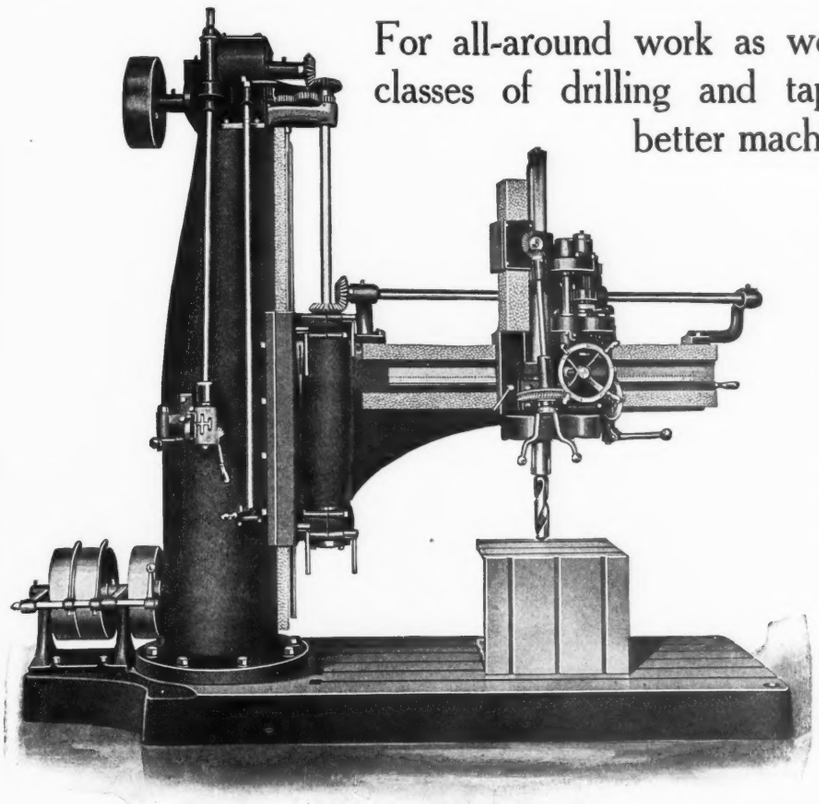
WORKS:

Madison, Wis. **Warren, Pa.**

FOREIGN AGENTS – Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm and Copenhagen. C. W. Burton, Griffiths & Co., England.

WESTERN DRILLS

For all-around work as well as the heaviest classes of drilling and tapping there is no better machine than this



6-Foot Triple Geared Plain Radial Drill
Full Line of Sizes

6-ft. Western Triple Geared, Plain Radial Drill

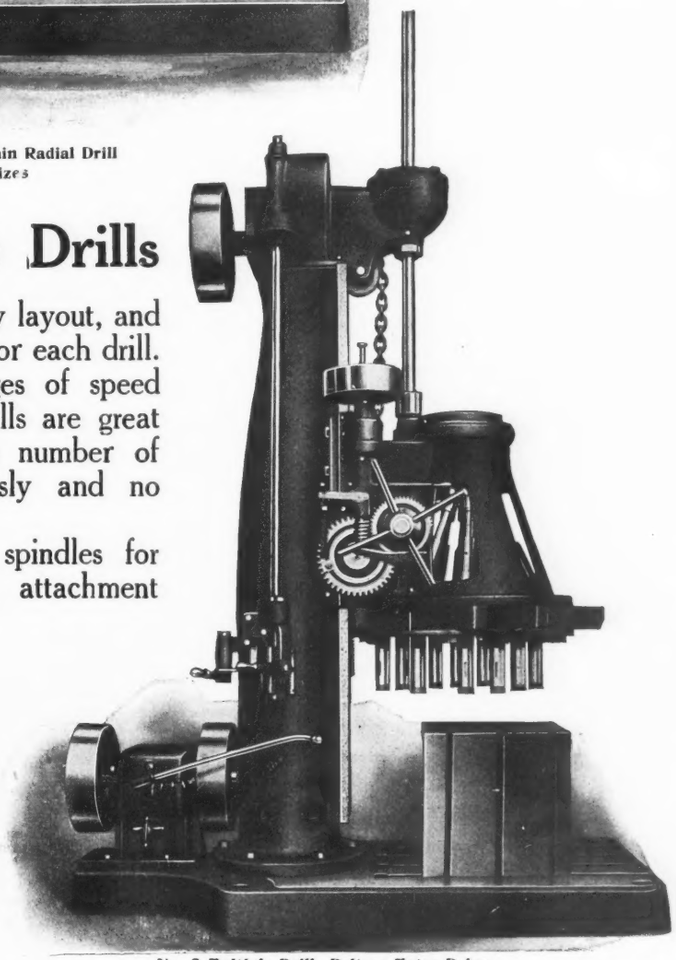
High ratio of gearing.
Great range of speeds.
Power applied to lower end of spindle, close to the work.

WRITE FOR DETAILS

Western Multiple Drills

Spindles adjustable to almost any layout, and independent vertical adjustment for each drill. Gear drive, six or eight changes of speed instantly obtainable. These drills are great savers of time — permit a large number of holes to be drilled simultaneously and no need to move the work.
Arranged with any number of spindles for special requirements. Tapping attachment when desired.

FULL LINE OF SIZES



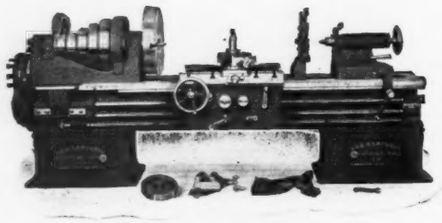
No. 2 Multiple Drill—Belt or Motor Drive

Western Machine Tool Works

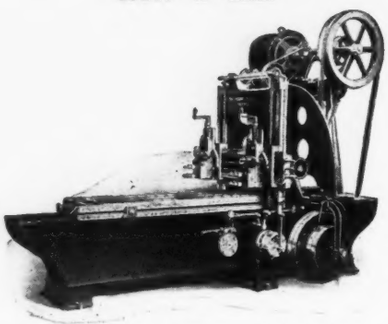
HOLLAND, MICH.

AGENTS—Hill, Clarke & Co., Boston, New York, Philadelphia, St. Louis and Chicago.
FOREIGN AGENTS—Alfred Herbert, Ltd., England. Alfred H. Schutte, Holland, Switzerland, Belgium, Italy, France and Spain.

THE ADVANTAGES OF "HAMILTON" TOOLS



26 x 10 "A" Lathe



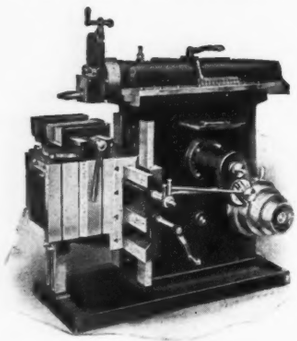
30 x 30 Spur Geared Planer, Motor Driven

are everywhere recognized as placing the machines in the front rank of modern shop equipment. Increased quantity and improved quality of output are the immediate results of their installation.

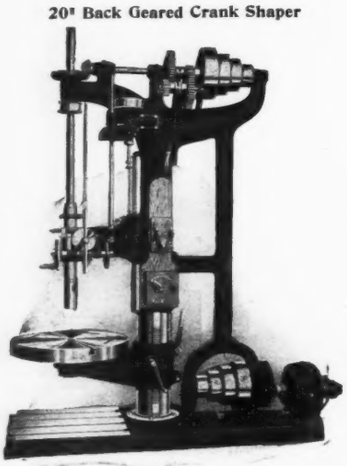
For heavy cuts ample strength and power are provided—quick operating facilities for handling the lighter work expeditiously. These points are carefully worked out in the design of the various sizes of

Lathes Planers Shapers Upright and Radial Drills

all of which contain many labor-saving features of practical utility. Special attention is given to accuracy and durability of construction, and each machine is given a thorough working test before shipment.



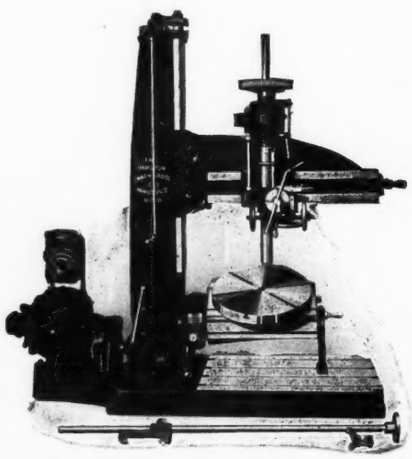
20" Back Geared Crank Shaper



36" Upright Drill Press, with Motor Drive

Motor drive and all usual attachments furnished when required.

Why not write to-day for printed matter and full information?

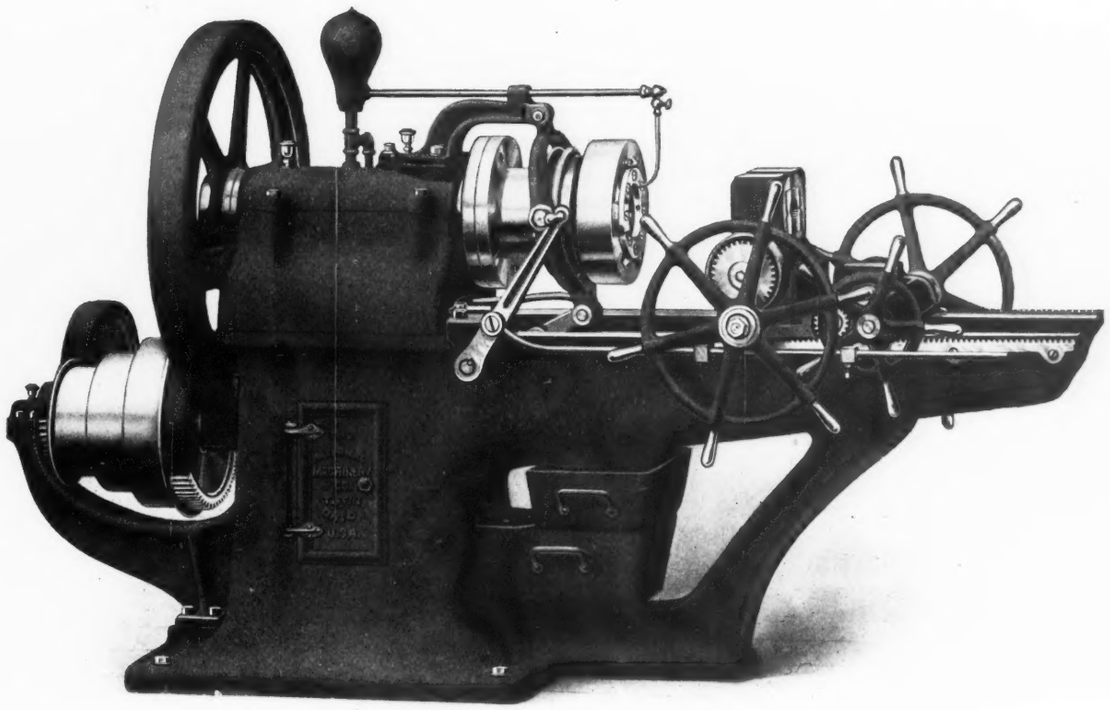


3½' Plain Radial Drill, with Motor Drive

THE HAMILTON MACHINE TOOL COMPANY

HAMILTON, OHIO, U. S. A.

Philadelphia Store, 48-50 N. 6th St. **Agents in the principal cities of the United States and Foreign Countries.**



National 3" Single Bolt Cutter

A large size bolt cutter must be built for the severest service. It must not only be able to cut perfect threads—as good as those chased in a lathe—but must be so rugged and massive that handling by cheap labor with its attendant abuse will not affect its life or accuracy. It requires years of experience (we have had 33) to develop a machine that will not only *work* but *last;* and the large sizes of National Bolt Cutters are offered to you with the assurance that comes from long and successful trial.

A machine on sixty days' approval will convince you.

We build complete equipment for Bolt and Nut Plants.

Our aim is to build our machines better, if anything, than need be. Hence we are in position to furnish only the best.

THE NATIONAL MACHINERY CO
TIFFIN, OHIO, U.S.A.

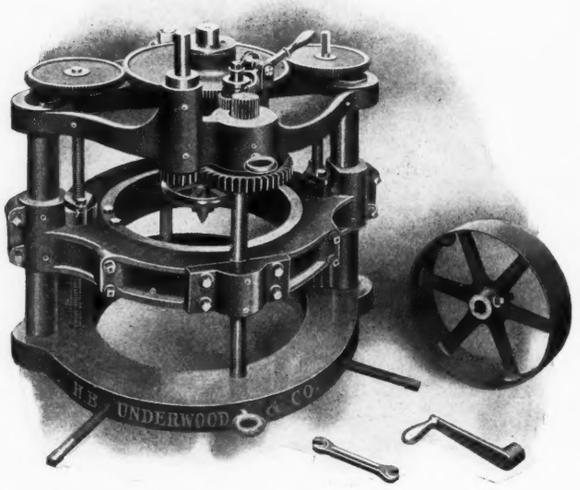
FOREIGN AGENTS

Buck & Hickman, Ltd., London, Birmingham, Manchester, Glasgow.
A. B. Horn, Havana, Cuba.
Takata & Co., Tokio, Japan.
Fenwick, Freres & Co., Paris, Liege, Brussels.
De Fries & Co., Dusseldorf, Berlin.
White, Child & Beney, Vienna, Austria.

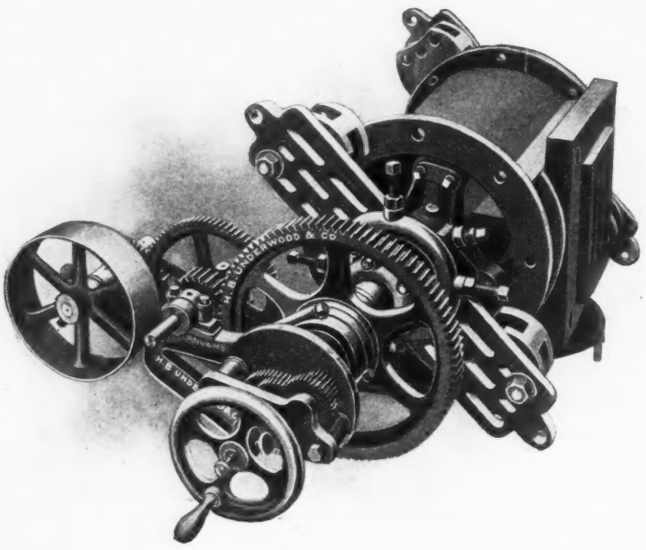
PORTABLE TOOLS

Crank Pin Turning Machines

Of the underwood make are strong and durable, but at the same time very light in weight; they feed either way, do their work quickly and accurately and are designed for trueing up worn or cut crank pins on engines of all kinds.



Made in five sizes—the largest with capacity for pins up to 20″ diameters—this size machine being intended for use with the heavy engines employed in rolling and steel mills.



Underwood Portable Boring Bar Mounted

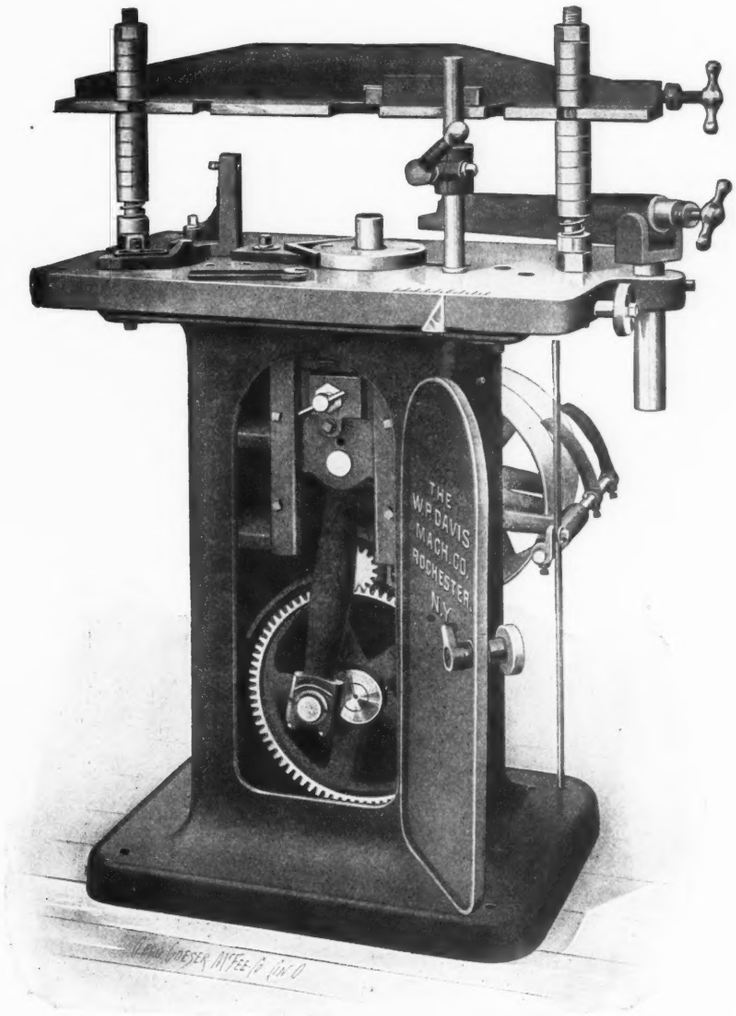
This tool, made in a variety of sizes, has fixtures for boring in any position and in very cramped places. It is readily operated in a space large enough to take the piston out of the cylinder, and saves 50 per cent. in time. Powerful, driven by hand or power; all kinds of engines, steam hammers, pumps, blowing engines, air compressors, Corliss valves, etc., can be bored in place.

Catalogue of Portable Tools mailed on request.

H. B. UNDERWOOD & COMPANY

1024 Hamilton St. (L. B. Flanders Machine Works) **Philadelphia, Pa.**

ACCURATE MACHINE TOOLS



Davis Key-Seater.

DO YOU REALIZE THAT WITH THIS MACHINE YOU CAN SAVE ITS COST EACH YEAR?

Always ready for use. Suitable for all internal key-seating in pulleys, gears, etc. No shop equipment is complete without this machine.

Thousands of these machines in use. Orders can be sent to us direct or through leading machinery dealers in all large cities of the world.

FOR FURTHER PARTICULARS ADDRESS

THE W. P. DAVIS MACHINE CO.,

ROCHESTER, N. Y., U. S. A.

The

Acme Automatic

Multiple Spindle

Screw Machine

The Machine

The Acme is a high grade special tool designed and adapted to eliminate all waste of time in the manufacture of **Duplicate Parts** from the bar.

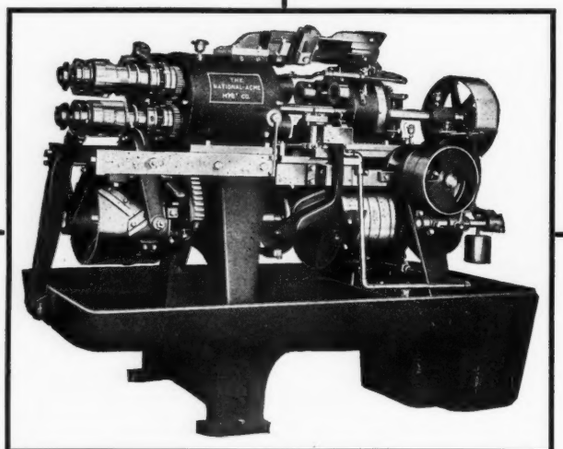
It does several things at one time—and does them all well.

The Product

The Acme way is the most modern method of screw making. The machine is equally well adapted for making all classes of **Duplicate Parts** from the bar.

Quality—As good as the best.

Quantity—Far greater than the next best.



Our Claim

The Acme is the **most economical** machine tool on the market for the manufacture of Duplicate Parts from the bar.

The Basis of Our Claim

The constant operation in our Product Department during the past ten years of a large and increasing number of Acmes on all classes of screw machine work.

Some Things To Consider

The Acme completes the piece in the length of time required for the longest single operation.

It costs no more to operate than any other screw machine.

It occupies no more floor space.

The

National-Acme Mfg. Co.

Cleveland, Ohio

Branch Offices

New York Boston Chicago

General Foreign Representatives

Alfred H. Schutte Schuchardt & Schutte

The Method

The Acme operates on four bars at a time.

It performs eight or more operations simultaneously.

It engages all the tools (one set only) at one and the same time.

Our new descriptive booklet will be mailed on request.

What Does the Salary Bag Hold for YOU?

Yes, that is a personal question, a very personal question—one that affects your whole life; and yet you would thank us for asking it if you knew what an immense power for betterment we could be to you and your salary.

To draw a small salary month after month, year after year, is your own fault. It is pure negligence and nothing else, for there is an institution which is ever ready to provide you with the qualifications that will enable you to rise to the highest, best paying positions in the profesions of your choice—an institution that can help you, no matter how poor your circumstances may be, how old or how young you are, no matter where you live. And to prove this the I. C. S. points to hundreds of thousands of other men who have secured advancement and success through the I. C. S. plan; to hundreds of others in worse circumstances than you are, whose stories of advancement read like romance; to a growth from a mere idea with one Course of Instruction to one of the largest educational institutions in the world with 208 Courses of Instruction, an invested capital of six million dollars, and a total enrolment far in excess of any other college in the world—a growth made possible only as the result of success in its business—and *the business of this place is to raise salaries.*

Without doubt this plan is the most practical, the quickest, easiest, and cheapest way in the world for *YOU* to secure a better position and increased earnings. It puts you under no obligation whatever to send us this coupon and allow our experts to explain our system of instruction, and adapt a Course to your personal needs.

Do you really want to earn more salary? Would you like the salary bag to yield you more each week or each month? Then make a definite attempt to bring this about by sending in this coupon. Tomorrow never comes. *Do it today.*

International Correspondence Schools

Box 980, SCRANTON, PA.

Please explain, without further obligation on my part, how I can qualify for a larger salary in the position before which I have marked **X.**

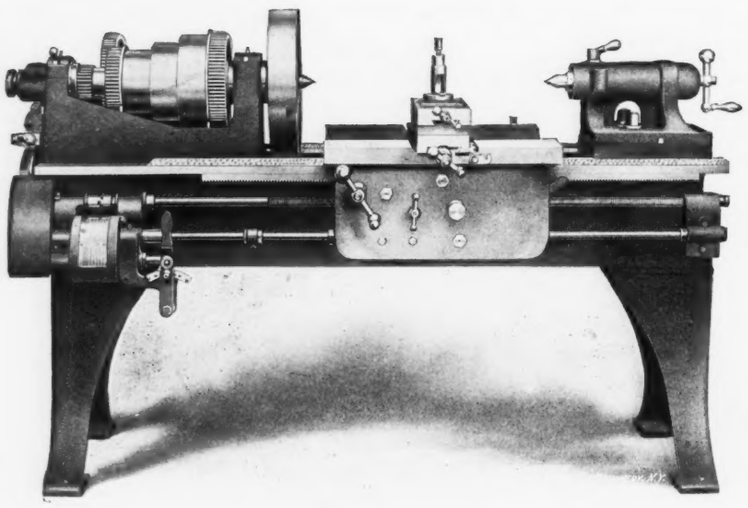
Electrical Engineer	Civil Engineer	Chemist
Electrical Mach. Des.	Stationary Engineer	Assayer
Dynamo Foreman	Gas Engineer	Illustrator
Electric-Light Supt.	Refrigeration Engineer	Bookkeeper
Electric-Railway Supt.	Foreman Machinist	Stenographer
Electrician	Foreman Toolmaker	Civil Service Exam.
Telephone Engineer	Foreman Molder	Commercial Law
Telegraph Engineer	Foreman Blacksmith	Architect
Mechanical Engineer	Sheet-Metal Draftsman	Structural Engineer
Machine Designer	Marine Engineer	Contractor & Builder
Mechanical Draftsman	Hydraulic Engineer	Ad Writer
Foreman Patternmaker	Mining Engineer	Window Trimmer

Name _____

Street and No. _____

City _____ *State* _____

A Wide Range of Speeds and Feeds



New 16-inch Engine Lathe

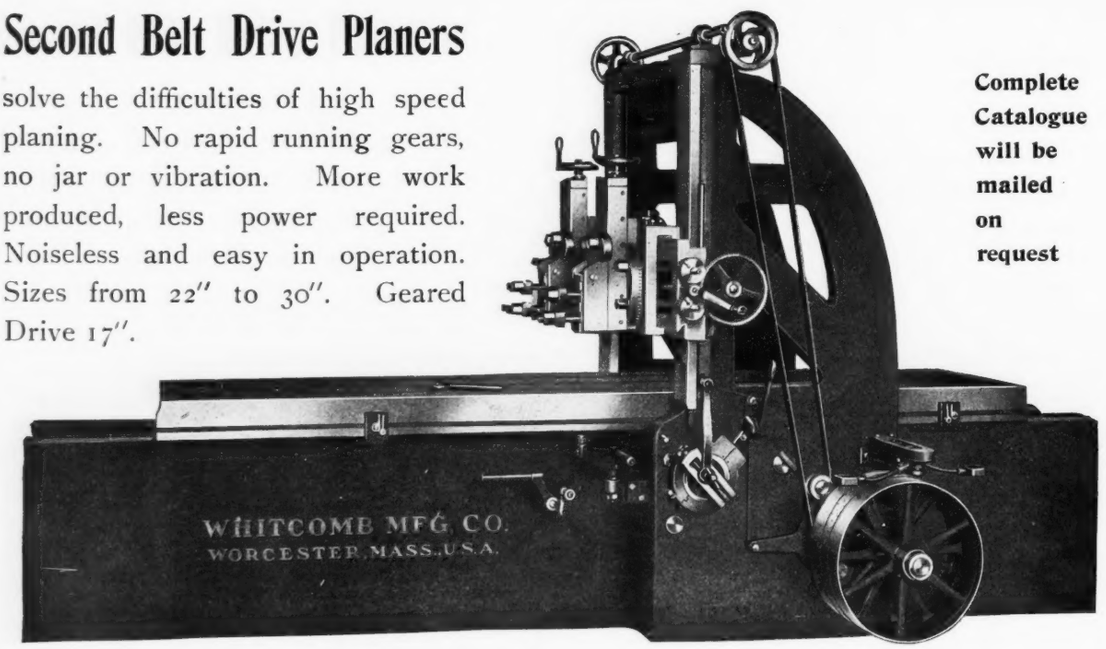
Unusual rigidity, a very powerful drive and increased facilities for operation are distinguishing points of this new model

16-inch Engine Lathe

It is designed to meet the needs of modern manufacturing and built to stand the strain of hard service and high speeds. Double back gears and an extra wide driving belt on the three-step cone provide ample power; there are nine speed changes readily obtained, and almost any feed is at your service. Write us for special circular.

Second Belt Drive Planers

solve the difficulties of high speed planing. No rapid running gears, no jar or vibration. More work produced, less power required. Noiseless and easy in operation. Sizes from 22″ to 30″. Geared Drive 17″.



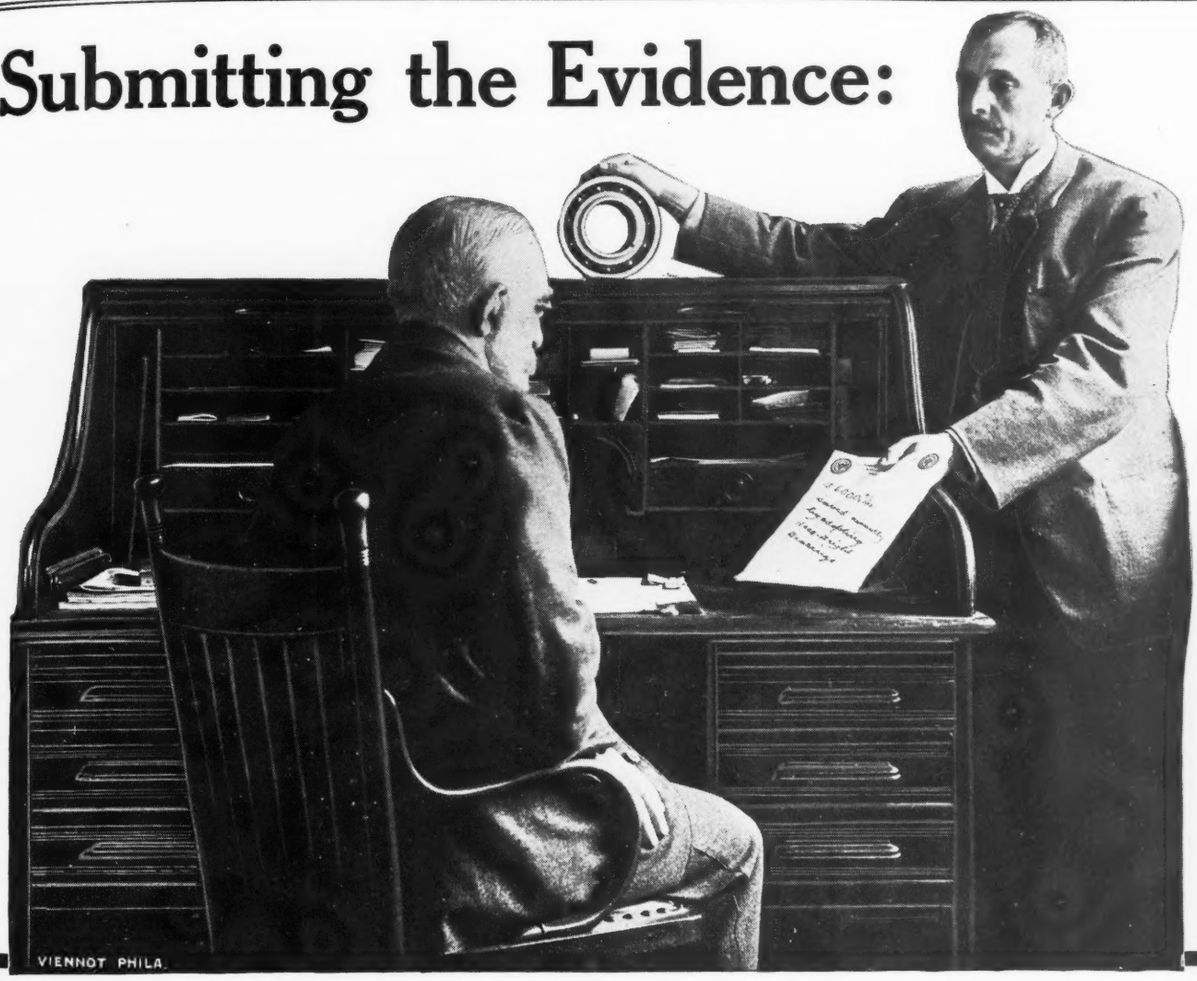
Complete Catalogue will be mailed on request

Whitcomb-Blaisdell Machine Tool Company

WORCESTER, MASS., U. S. A.

AGENTS: Hill, Clarke & Co., Boston and Chicago. Vandyck Churchill Co., New York and Philadelphia. Thomas & Lowe Machinery Co., Providence, R. I. C. H. Wood Co., Syracuse, N. Y. McDowell, Stocker & Co., Chicago, Ill. Marshall & Huschart Machinery Co., St. Louis, Mo. Patterson Tool and Supply Co., Dayton, Ohio. J. L. Osgood, Buffalo, N. Y. H. B. Perine, Seattle, Wash. Pacific Tool and Supply Co., San Francisco, Cal. Somers, Fitler & Todd Co., Pittsburg, Pa. Chas. A. Strelinger Co., Detroit, Mich. Zimmerman-Wells-Brown Co., Portland, Ore. L. Booth & Sons, Los Angeles, Cal. C. W. Burton, Griffiths & Co., London, England. Fenwick Freres & Co., Paris, France. Ludw. Loewe & Co., Berlin, Germany. De Fries & Co., Dusseldorf, Germany. Wilh. Sonesson & Co., Malmo, Sweden. Van Rietschoten & Houwens, Rotterdam, Holland. Williams & Wilson, Montreal, Canada. A. R. Williams Mchy. Co., Toronto, Canada.

Submitting the Evidence:



$6,000.00 Saved Annually on a 500-horsepower plant by changing from the old-style shaft bearings to

Hess-Bright Ball Bearings

Doesn't seem possible, does it? Yet here are the facts and figures.

Take, for example, a 500 H. P. plant. Suppose the friction load to be 33% of the total H. P. (Tests by eminent engineers show the average machine shop carries a 55% friction load.) Substitution of Hess-Bright Ball Bearings would reduce this to 3% or less—thus, (33%—3%) X 500 H. P. = 150 H. P. saved. 150 H. P. at $40 per H. P. year = $6,000 annual saving.

That is not all—some ordinary bearings need oiling daily, others weekly, and so on; Hess-Bright Ball Bearings need attention not over twice a year.

Belts are relieved of strain, adding years to their life; and machines run easier, enabling more work to be turned out.

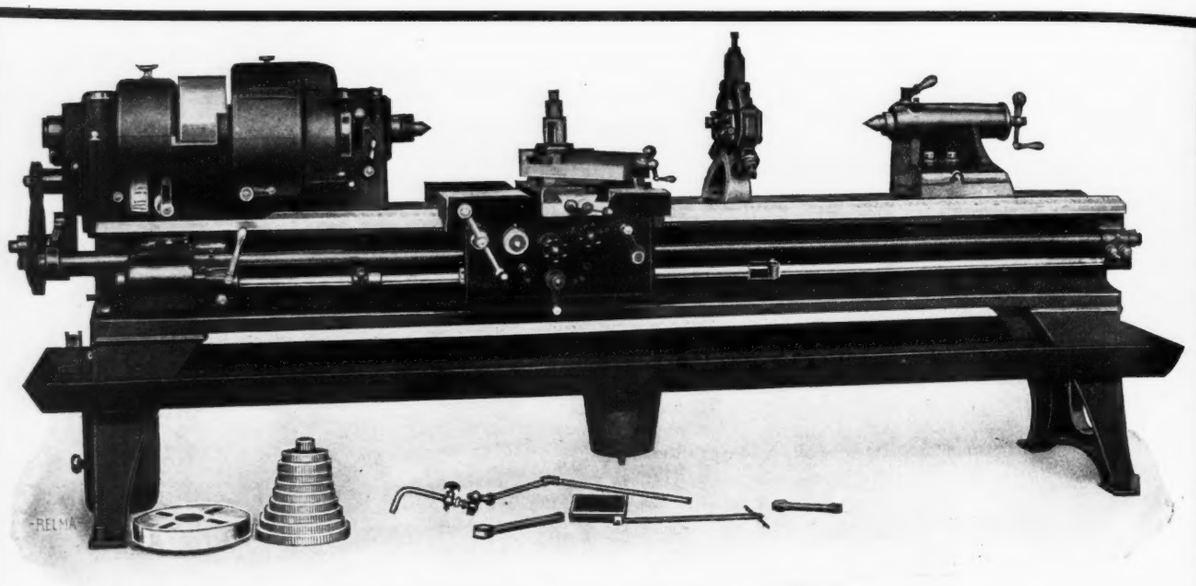
Now, the question that probably is running through your mind is: What will the cost of installation be?

Not nearly so much as the saving the first year, unless you have a very unusual plant; and the change can be made over night, without changing your hangers or disturbing the regular routine of work.

Will you give us an opportunity to tell you what we can do in your case? The estimate won't cost you anything.

The Hess-Bright Manufacturing Co.

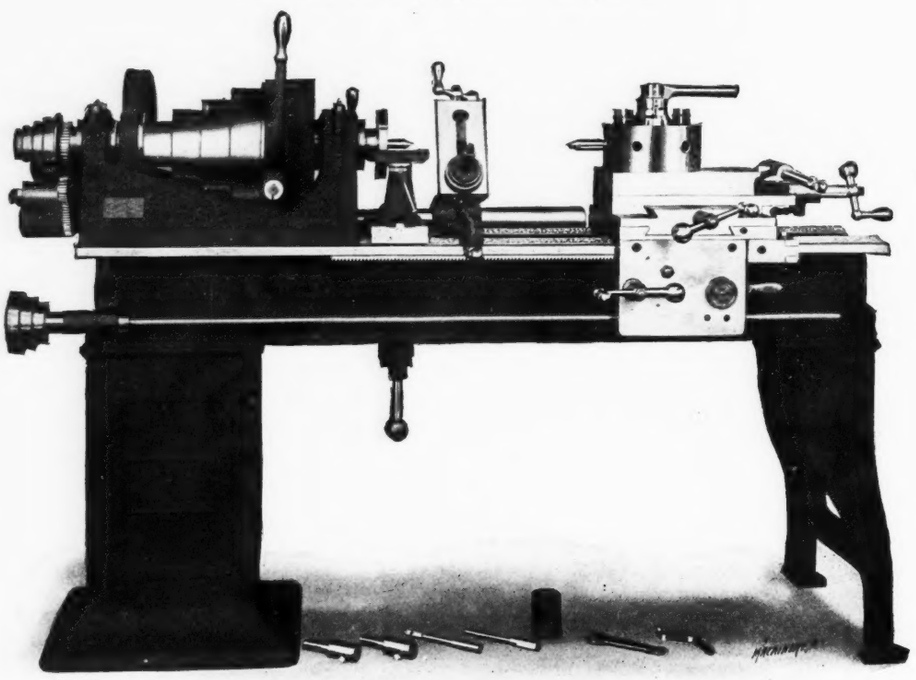
19th and Hamilton Streets, Philadelphia, Pa.



Springfield High Power Rapid Reduction Lathe No. 3

A high speed lathe that is a power in its field. Provided with instantaneous change of positive gear feeds, heavy carriage and double apron, new compound rest. Exceptionally accurate, practically noiseless and easy to operate.

Circular No. 124 explains. Ask for it.



Springfield Cabinet Turret Lathe

This 18″ x 6′ machine is particularly adapted for brass work. Improved turret head and clutch mechanism facilitates rapid handling. Fitted with friction geared head; both hand and power longitudinal feed for the turret and carriage.

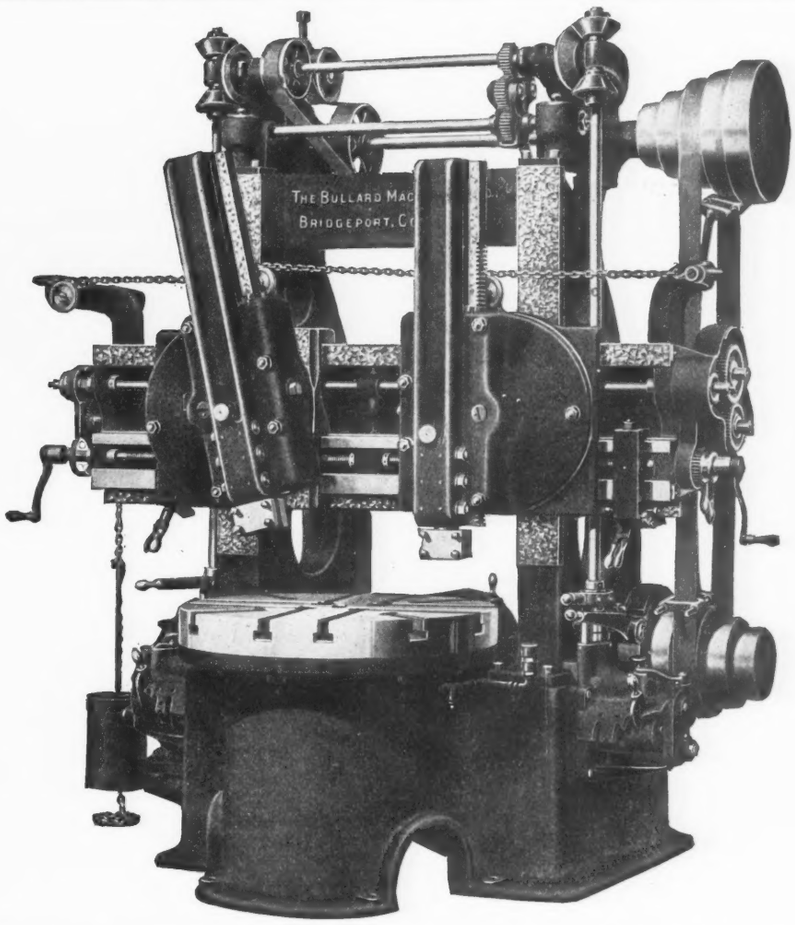
Ask for Circular No. 105.

We make a full line of time and labor saving machine tools.

The Springfield Machine Tool Co., Springfield, O.

Agents for Italy, Ing. Vaghi, Accornero & Co., Milan. Ludw. Loewe & Co., Berlin, Germany, Agents.

The Way To Know A Modern Boring Mill



BULLARD

Selecting a Boring Mill in these days of keen competition requires not only careful consideration on the part of the buyer, but also a knowledge of how such a machine must be designed and what features it must have in order to do his work quicker than by any other method and yet do it accurately.

Getting the best of the "other fellow" may not be ethical, but it's business, and if you'll ask yourself the following questions before deciding on a Mill, and insist on getting a machine with such features, you needn't worry about competition:

1st—Are the working parts and frame of proper material, weight and design to take as heavy a cut as modern high-speed steels will stand?

2nd—Has the machine been in actual service long enough for any weakness to develop?

3rd—Does power operate the heads and slides at the rate of 1 ft. in 12 seconds?

4th—If operator forgets and allows heads to run together, is there a safety device to prevent breakage?

5th—Is machine provided with a brake so that table can be stopped instantly at any desired point?

6th—Are the feeds for each head entirely independent and positive?

7th—Is the table spindle self centering so that accurate work can be done after machine has been in use a while?

8th—Can the cross-rail be raised and lowered by power?

9th—Are high-speed journals all bronze bushed and self oiling, and the gears incased?

10th—Can motor be applied at any time without reconstructing the Mill and without extra parts?

All of the above features, and many more, will be found in Bullard Mills. A study of the machines shown in our catalog will further enlighten you about Boring Mills. *Ask for Catalog No. 31.*

The Bullard Machine Tool Co.

531 BROAD ST.
BRIDGEPORT, CONN., U. S. A.

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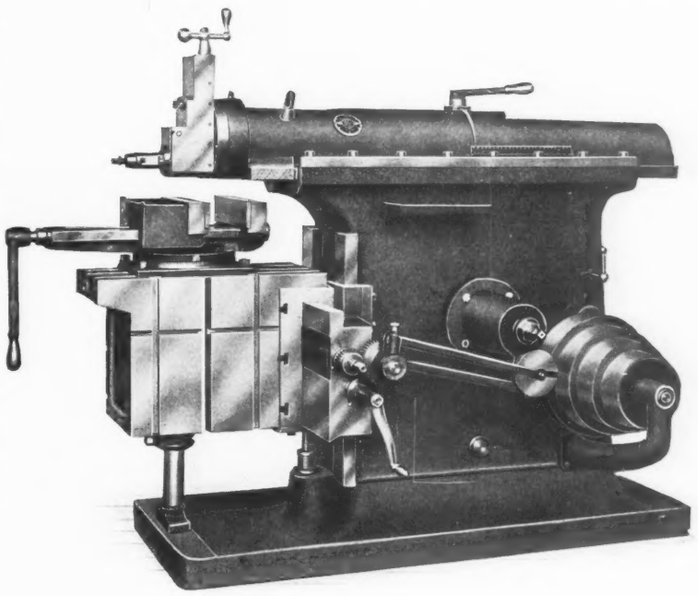
The construction of this shaper is the strongest throughout; ample weight properly distributed eliminates vibration even under the heaviest cuts. The ram is extra heavy, rocker arm of special design; it has table support, telescopic screw and every improvement for rapid and convenient operation. Actual stroke, 26 inches. The gearing is so arranged that the machine can be used single or back geared as desired—ratio is 6 to 1 single and 24 to 1 back geared, with a range of strokes from 8 to 72 per minute.



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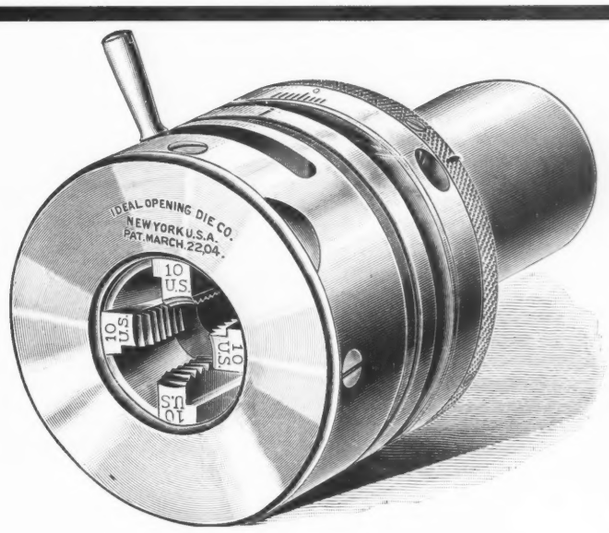

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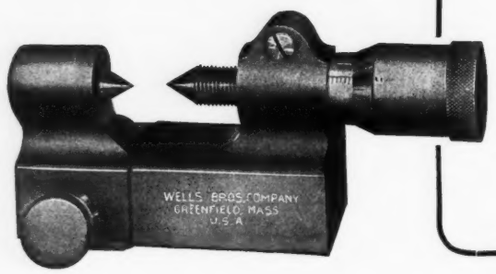

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It was just a common jack straw placed between the intermeshing steel wire cells, which are the product of

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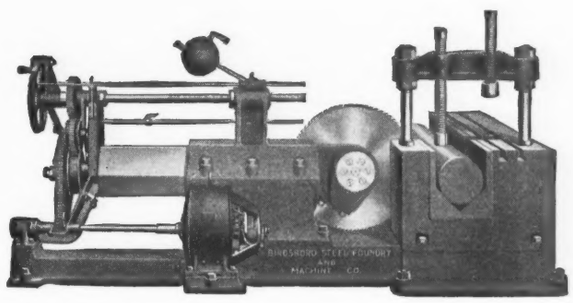
and it looked easy to break. When these two husky young fellows tried it however, they found their utmost endeavor at twisting and pulling to be absolutely vain. When the regulation raw hide, or steel pin is used, the joint is much stronger than any other part of the belt, and is so compact that it passes over the smallest pulley without slipping, pounding or strain. Cost? Why you can lace a 5″ belt in 3 minutes, at a cost for material of one cent. Better send for a catalog.



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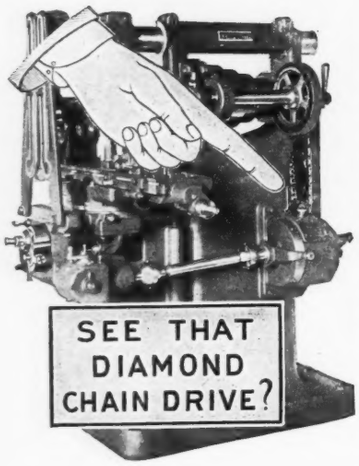
Birdsboro, Pa.



Perhaps one like it is just what you need to make your machine perfect. It occupies only half the space of a belt and never slips. It doesn't stretch in wet weather and never has to be "doped" or tightened. Oil that may be spattered on helps it instead of spoiling it. Nickel steel rivets found only on Diamond Chains, and scientifically tempered bearing surfaces lessen wear, therefore this chain always works better and lasts longer than others We can show you how and why Diamond Drives win out every time on short transmissions and moderate speeds. Send us a sketch with particulars concerning your needs and we will lay out a drive for you and refer you to similar cases where Diamond Chains are giving more service and better service than any other doing the work.

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Detroit Twist Drill Co., Detroit, Mich.
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Pratt & Whitney Co., Hartford, Conn.
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Three Rivers Tool Co., Three Rivers, Mich.
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Betts Mch. Co., Wilmington, Del.
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Dreses Mch. Tool Co., Cincinnati, O.
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Western Mch. Tool Works, Holland, Mich.
Wiley & Russell Mfg. Co., Greenfield, Mass.
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Clark, Jas., Jr., & Co., Louisville, Ky.
Dallett, Thos. H., Co., Philadelphia, Pa.
Hisey-Wolf Mch. Co., Cincinnati, O.
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Standard Tool Co., Cleveland, O.

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American Blower Co., Detroit, Mich.
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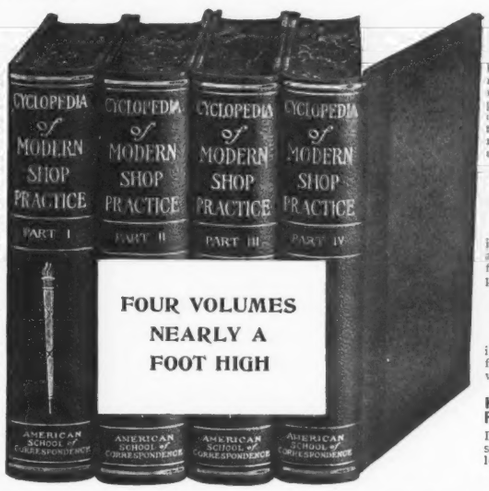

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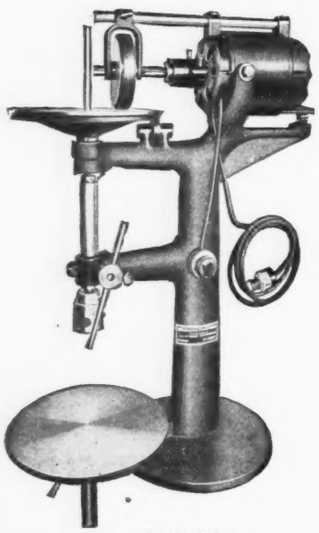

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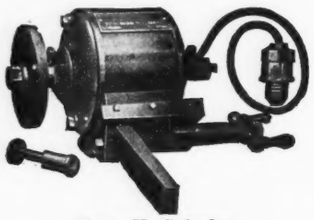

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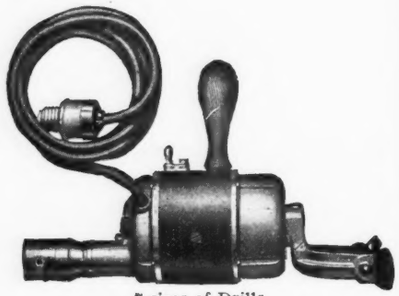

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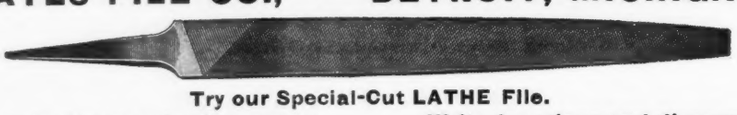

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B. F. Sturtevant Co., Hyde Park, Mass.

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Wyman & Gordon, Worcester, Mass.

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Furnaces, Liquid Fuel.
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Gould & Eberhardt, Newark, N. J.
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Werner & Pfleiderer, Saginaw, Mich.

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Eberhardt Bros. Mch. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
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Pratt & Whitney Co., Hartford, Conn.
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Crocker-Wheeler Co., Ampere, N. J.
General Elec. Co., Schenectady, N. Y.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Classified Index to Advts. (Continued).

Graphite.
Jos. Dixon Crucible Co., Jersey City, N. J.
S. Obermayer Co., Cincinnati, O.
Grinders, Portable Electrical Driven.
Chicago Pneu. Tool Co., Chicago, Ill.
Cincinnati Elec. Tool Co., Cincinnati, O.
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Hisey-Wolf Mch. Co., Cincinnati, O.
United States Elec. Tool Co., Cincinnati, O.
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Becker-Brainard Milling Mch. Co., Hyde Park.
C. H. Besly & Co., Chicago, Ill.
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Brown & Sharpe Mfg. Co., Providence, R. I.
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Diamond Mch. Co., Providence, R. I.
Gould & Eberhardt, Newark, N. J.
Graham Mfg. Co., Providence, R. I.
Hisey-Wolf Mch. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co., Erie, Pa.
Ney, R. W., Kingston, N. Y.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Ransom Mfg. Co., Oshkosh, Wis.
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Saxon Mch. Co., Holyoke, Mass.
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Ransom Mfg. Co., Oshkosh, Wis.
Grinding Machines, Plain Universal.
Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Dayton Mch. & Tool Wks., Dayton, O.
Landis Tool Co., Waynesboro, Pa.
Niles-Bement-Pond Co., New York.
Norton Grinding Co., Worcester, Mass.
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Beaudry & Co., Inc., Boston, Mass.
Niles-Bement-Pond Co., New York.
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Hoists, Electric.
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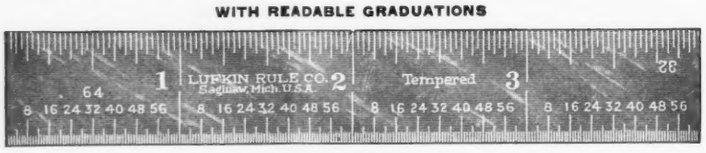

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New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.
F. E. Reed Co., Worcester, Mass.
Rivett Lathe Mfg. Co., Brighton, Mass.
Robbins Mch. Co., Worcester, Mass.
Schumacher & Boye, Cincinnati, O.
Sebastian Lathe Co., Cincinnati, O.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Newark, N. J.
Springfield Mch. Tool Co., Springfield, O.
Stark Tool Co., Waltham, Mass.
Von Wyck Mch. Tool Co., Cincinnati, O.
Walcott & Wood Mch. Tool Co., Jackson, Mich.
Waltham Mch. Wks., Waltham, Mass.
Warner & Swasey Co., Cleveland, O.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.

Lathe and Planer Tools.
Armstrong Bros. Tool Co., Chicago, Ill.
Fairbanks Co., Springfield, O.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Lifting Magnets.
Browning Eng'r'g Co., Cleveland, O.
Elec. Cont. & Supply Co., Cleveland, O.

Lockers.
Federal Steel Fixture Co., Chicago, Ill.
Hart & Cooley Co., New Britain, Conn.

Lubricants.
C. H. Besly & Co., Chicago, Ill.
Joseph Dixon Crucible Co., Jersey City, N. J.

Machine Keys.
Morton Mfg. Co., Muskegon Heights, Mich.
Olney & Warrin, New York.
Standard Gauge Steel Co., Beaver Falls, Pa.

Machine Shop Furniture.
Federal Steel Fixture Co., Chicago, Ill.
Mfg. Equip. & Eng'rg Co., Boston, Mass.

Machinery Dealers, Domestic.
Frevert Mchy. Co., New York.
J. J. McCabe, New York.
Motch & Merryweather Mchy. Co., Cleveland, O.
Prentiss Tool & Supply Co., New York.
Toomey, Frank, Philadelphia, Pa.
Vandyck Churchill Co., New York.

Machinists' Small Tools.
Athol Mch. Co., Athol, Mass.
C. H. Besly & Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers Works, Gloucester City, N. J.
Sawyer Tool Mfg. Co., Fitchburg, Mass.
J. T. Slocomb Co., Providence, R. I.
E. G. Smith Co., Columbia, Pa.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.
Syracuse Twist Drill Co., Syracuse, N. Y.
Wells Bros. Co., Greenfield, Mass.
J. Wyke & Co., Boston, Mass.

Mandrels.
Cleveland Twist Drill Co., Cleveland, O.
W. H. Nicholson & Co., Wilkesbarre, Pa.

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Classified Index to Advts. (Continued).

Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Western Tool & Mfg. Co., Springfield, O.

Mechanical Draft.
American Blower Co., Detroit, Mich.
B. F. Sturtevant Co., Hyde Park, Mass.

Metal.
Goldschmidt Thermit Co., New York.
New Era Mfg. Co., Kalamazoo, Mich.
Phosphor Bronze Smelting Co., Philadelphia, Pa.
Ryerson, Joseph T., & Son, Chicago, Ill.

Metal, Anti-Friction.
Ryerson, Joseph T., & Son, Chicago, Ill.

Metal Polish.
Hoffman, George W., Indianapolis, Ind.

Metal Sawing Machines.
Cochrane-Bly Co., Rochester, N. Y.

Milling Machines.
Adams Co., Dubuque, Ia.
Beaman & Smith Co., Providence, R. I.
Becker-Brainard Milling Mch. Co., Hyde Park.
Burke Mchy. Co., Cleveland, O.
Cincinnati Milling Mch. Co., Cincinnati, O.
Fox Mch. Co., Grand Rapids, Mich.
Garvin Mch. Co., New York.
Hendey Mch. Co., Torrington, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
Kearney & Trecker, Milwaukee, Wis.
Kempsmith Mfg. Co., Milwaukee, Wis.
Knight, W. B., Mchy. Co., St. Louis, Mo.
R. K. Le Blond Mch. Tool Co., Cincinnati, O.
Newton Mch. Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Owen Mch. Tool Co., Springfield.
Pratt & Whitney Co., Hartford, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Slate, Dwight, Mch. Co., Hartford, Conn.
Waltham Watch Tool Co., Springfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Milling Cutters.
Becker-Brainard Milling Mch. Co., Hyde Park.
Boker, Hermann, & Co., New York and Chicago.
Boston Gear Works, Norfolk Downs, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Garvin Mch. Co., New York.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
L. S. Starrett Co., Athol, Mass.

Milling Tools (Hollow Adjustable).
Geometric Tool Co., New Haven, Conn.

Molding Machines.
S. Obermayer Co., Cincinnati, O.

Motors.
Steffey Mfg. Co., Philadelphia, Pa.

Motors (Electric).
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Wks., Belleville, N. J.
General Electric Co., Schenectady, N. Y.
Guarantee Electric Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, O.
Lincoln Motor Works Co., Cleveland, O.
Robbins & Myers Co., Springfield, O.
B. F. Sturtevant Co., Hyde Park, Mass.
Western Electric Co., Chicago, Ill.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Name Plates.
Becker, August, Engraving Co., Boston, Mass.
Sackmann, W. L., Akron, O.
Turner Brass Works, Chicago, Ill.

Nozzles.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Nut Tappers.
Acme Mchy. Co., Cleveland, O.
National Mchy. Co., Tiffin, O.

Oil Cans.
Delphos Mfg. Co., Delphos, O.

Oil Cups.
Bay State Stamping Co., Worcester, Mass.
C. H. Besly & Co., Chicago, Ill.
W. M. & C. F. Tucker, Hartford, Conn.
Winkley Co., Detroit, Mich.

Oil Hole Covers.
Bay State Stamping Co., Worcester, Mass.
W. M. & C. F. Tucker, Hartford, Conn.
Winkley Co., Detroit, Mich.

Oilless Bearings.
Arguto Oilless Bearing Co., Philadelphia, Pa.

Oil Stones.
Norton Co., Worcester, Mass.
Star Corundum Wheel Co., Ltd., Detroit, Mich.

Packing.
Houghton E. F., & Co., Philadelphia, Pa.
Jenkins Bros., New York.
New York Belting and Packing Co., New York.

Patterns, Wood and Metal.
Penn Pattern Wks., Chester, Pa.

Pattern Letters.
Butler, A. G., New York.

Patents.
Burnham, Royal E., Washington, D. C.
Howson & Howson, Philadelphia, Pa.
Macdonald & Macdonald, New York.
Parker, C. L., Washington, D. C.
Stevens, Milo B., & Co., Washington, D. C.
Whittlesey, Geo. P., Washington, D. C.

Pattern Shop Equipment.
Colburn Mch. Tool Co., Franklin, Pa.
Fox Machine Co., Grand Rapids, Mich.

Phosphorizers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

Pipe-Cutting and Threading Tools.
Armstrong Mfg. Co., Bridgeport, Conn.
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Hart Mfg. Co., Cleveland, O.
Loew Mfg. Co., Cleveland, O.
Merrell Mfg. Co., Toledo, O.
Murchey Mch. & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.

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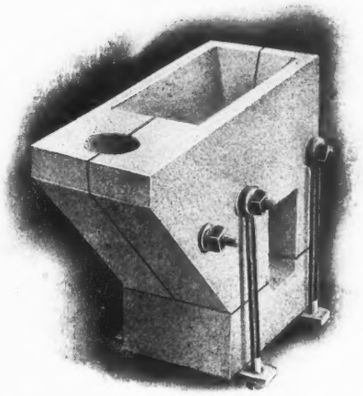
Locomotive Frame Repairs



have been much simplified by the use of our new

Fire Brick Moulds

as we are in a position to furnish them in standard sizes to fit a great variety of frames, thus permitting of the repair being made in division shops and round houses without the aid of pattern makers or moulders.

THERMIT WELDS

not only furnish a quick means of repairing broken locomotive frames and drivers, but actually make them STRONGER than they were originally, as, by our process, a fused collar or reinforcement is left around the weld.

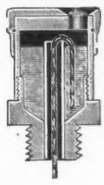
Write for Pamphlet No. 15A

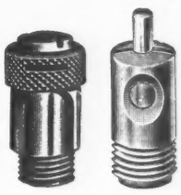
Goldschmidt Thermit Company
90 WEST STREET, NEW YORK CITY
432-436 Folsom Street - - - San Francisco

SAVE WORK AND WEAR.

Oil Hole Covers and Oil Cups save work for the engineer or machinist, and save wear on delicate machinery by keeping oil channels free from dust. The **Winkley Oil Hole Covers** are the original covers and are made in many styles and sizes to suit all kinds of machinery. Dust proof, self closing, easly cleaned, economical and an ornament to any machine. *Send for booklet, "Oiling Devices."*

Style J. Reservoir Oil Cup.





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Of Every Description.

BUTTERFIELD & CO.,

DERBY LINE, VERMONT.
ROCK ISLAND, CANADA.

No plugging up. Oil tight and dust proof.

Handy Oilers

Bay State Stamping Co.,
Worcester, Mass.

European Agents, Chas. Churchill & Co. London, Eng.

DUST PROOF AND OIL TIGHT
OIL HOLE COVERS

Style C.

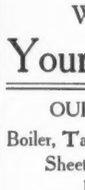
is a Definite Statement.

OUR STYLE "A" COVER GOES YOU ONE BETTER

It is used as an air valve. Can this be done with any other cover?

Style A.

Style B.



Send for samples and price lists.

GET BUSY WITH
W. M. & C. F. TUCKER,
Hartford, Conn.

PACIFIC COAST AGENT—C. Ducommun, Los Angeles, Cal. FOREIGN AGENTS—Fenwick Freres & Co., Paris, France. C. W. Burton Griffiths & Co., London, Eng.

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Weldless Rings, Steel Forgings.

10 per cent. to 25 per cent. more blanks can be cut by dies finished from our Forgings. Our steel is made especially for us and we forge by a process that is all our own.

HAY-BUDDEN MFG. CO.
254 No. Henry St., Brooklyn, N. Y.

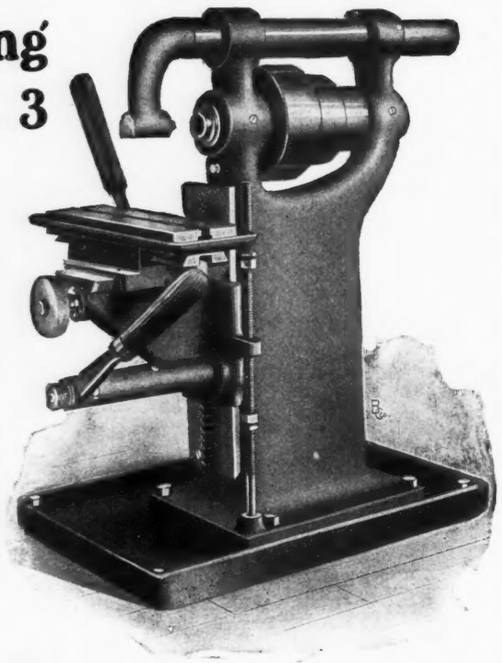
WE WANT TO DO
Your Machine Work

OUR SPECIALTIES INCLUDE

Boiler, Tank and Sheet Iron Work	Copper Work
Patterns	Pipe Bending
	Blacksmithing

SKINNER SHIP BUILDING & DRY DOCK CO.
BALTIMORE, MARYLAND

Burke Milling Machine No. 3

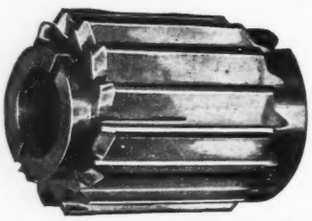


Longitudinal feed of table 6″; Traverse feed 2½″; Vertical motion to knee 8¾″; Maximum distance between center of spindle and table 7″; Working surface of table 3½ x 12; Greatest distance between centers (6″ swing) 5½″; Largest diameter of cone 6″; Smallest diameter of cone 3½″; Driving belt 2″; Taper hole in spindle B. & S. No. 8; Hole in spindle ½″; Height over all 26″; Loose pulley on countershaft 7 x 2¼; Speed of countershaft 280 revolutions.

Write for prices and details.

The Burke Machinery Co., Cleveland, Ohio

High Speed Service at Low Speed Cost



Matthews High Speed Reamers and Core Drills

have blades of high-speed steel brazed into a soft steel body and give five to six times the service of carbon steel tools.

No loose blades; hard cutting edges; less resharpening needed; more speed, more work and less cost per piece done.

Write for Price List and Testimonial Leaflet.

Three Rivers Tool Company, Dept. M, Three Rivers, Mich.

Universal Adjustable Reamers

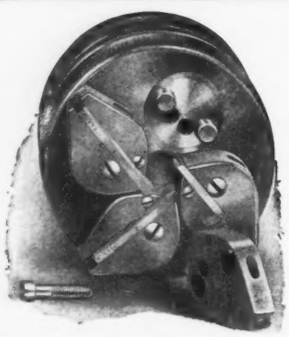
Construction, Quality and Workmanship the Best.

Send for Catalogue.

If you have used our reamers you know their merits. If not, a trial order will convince you. Or to convince you we will send you a reamer, and if you are not satisfied in every respect, you may return it.

The Schellenbach & Darling Tool Co., Cincinnati, Ohio

Agents for Great Britain: C. W. Burton, Griffiths & Co., London.



You Can Reckon to Save

Time, money and trouble in bolt cutting with the Landis Bolt Machines—

THE IMPROVED LANDIS DIE

doubles the production of work, gives twenty times the service of a hobbed die, requires no annealing or retempering, has positive lead, correct clearance, and covers a wide range of special work. Let us send you the book.

Landis Machine Co.
Waynesboro, Pa.

Schuchardt & Schutte, Sole Representatives for England, China and Japan

Classified Index to Advts. (Continued).

D. Saunders' Sons, Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Williams Tool Co., Erie, Pa.

Planers, Metal.
American Tool Wks. Co., Cincinnati, O.
Betts Mch. Co., Wilmington, Del.
Cincinnati Planer Co., Cincinnati, O.
Cleveland Planer Wks., Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Flather, Mark, Planer Co., Nashua, N. H.
Gleason Works, Rochester, N. Y.
G. A. Gray Co., Cincinnati, O.
Hamilton Mch. Tool Co., Hamilton, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Whitcomb-Blaisdell Mch. Tool Co., Worcester.
W. A. Wilson Mch. Co., Rochester, N. Y.

Plumbago.
S. Obermayer Co., Cincinnati, O.
Paxson, J. W., & Co., Philadelphia, Pa.

Pneumatic Drills, Hammers, Grinders, etc.
Chicago Pneu. Tool Co., Chicago, Ill.
Independent Pneu. Tool Co., Chicago and N. Y.
Ingersoll-Rand Co., New York.

Pneumatic Tools.
Chicago Pneu. Tool Co., Chicago, Ill.
General Pneu. Tool Co., Montour Falls, N. Y.
Independent Pneu. Tool Co., Chicago and N. Y.
Ingersoll-Rand Co., New York.
Manning, Maxwell & Moore, Inc., New York.

Presses.
Billings & Spencer Co., Hartford, Conn.
E. W. Bliss Co., Brooklyn, N. Y.
Burroughs, Charles, Co., Newark, N. J.
Garvin Mch. Co., New York.
Hamilton Mch. Tool Co., Hamilton, O.
Hoefer Mfg. Co., Freeport, Ill.
Lucas Mch. Tool Co., Cleveland, O.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Springfield Mch. Tool Co., Springfield, O.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Pulley Blocks.
Yale & Towne Mfg. Co., New York.

Pulleys.
American Pulley Co., Philadelphia, Pa.
Jeffrey Mfg. Co., Columbus, O.
Latshaw Pressed Steel & Pulley Co., Pittsburg, Pa.
Poole Eng'r'g & Mch. Co., Baltimore, Md.
Saginaw Mfg. Co., Saginaw, Mich.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Wood's Sons, T. B., Co., Chambersburg, Pa.

Pumps.
Burroughs, Charles, Co., Newark, N. J.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.

Punches and Dies.
Armstrong-Blum Mfg. Co., Chicago, Ill.
Burke Mchy. Co., Cleveland, O.
Globe Mch. & Stamping Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
I. P. Richards, Providence, R. I.
Watson-Stillman Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Punching and Shearing Machinery.
Bertsch & Co., Cambridge City, Ind.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
E. W. Bliss Co., Brooklyn, N. Y.
Cincinnati Punch & Shear Co., Cincinnati, O.
Kripps-Mason Mch. Co., Philadelphia, Pa.
Long & Allstatter Co., Hamilton, O.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Royersford Foundry & Mch. Co., Royersford, Pa.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Toledo Mch. & Tool Co., Toledo, O.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Watson-Stillman Co., New York.
Williams, White & Co., Moline, Ill.

Rapping Plates.
Milwaukee Fdry. Supply Co., Milwaukee, Wis.

Reamers.
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford.
Pratt & Whitney Co., Hartford, Conn.
John M. Rogers Works, Gloucester City, N. J.
Schellenbach & Darling Tool Co., Cincinnati, O.
Standard Tool Co., Cleveland, O.
Three Rivers Tool Co., Three Rivers, Mich.
Van Dorn Electric & Mfg. Co., Cleveland, O.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reamers, Adjustable.
Lapointe Machine Tool Co., Hudson, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Works, Gloucester City, N. J.

Reamers, Pneumatic.
Independent Pneu. Tool Co., Chicago and N. Y.
Stow Flexible Shaft Co., Philadelphia, Pa.

Rivet and Spike Machinery.
National Mchy. Co., Tiffin, O.

Riveters.
Chambersburg Engineering Co., Chambersburg, Pa.
General Pneumatic Tool Co., Montour Falls, N. Y.
Grant Mfg. & Mch. Co., Bridgeport, Conn.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Wm. Sellers & Co., Inc., Philadelphia, Pa.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.

Roller Bearings.
Bantam Anti-Friction Co., Bantam, Conn.
Hess-Bright Mfg. Co., Philadelphia, Pa.

Saw Blades.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Massachusetts Saw Wks., Chicopee, Mass.

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Millers Falls Co., New York.
West Haven Mfg. Co., New Haven, Conn.

Saw Sharpening Machines.
Cochrane-Bly Co., Rochester, N. Y.

Saw Tables.
Crescent Mch. Co., Leetonia, Ohio.
Hub Mch. & Tool Co., Philadelphia, Pa.

Saws, Power and Hand.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
Diamond Saw & Stamping Wks., Buffalo, N. Y.
Espen-Lucas Mch. Wks., Philadelphia, Pa.
Millers Falls Co., New York.
H. T. Story, Chicago, Ill.
Robertson Mfg. Co., Buffalo, N. Y.
Tabor Mfg. Co., Philadelphia, Pa.
West Haven Mfg. Co., New Haven, Conn.

Saws, Band.
Crescent Mch. Co., Leetonia, O.
Fox Mch. Co., Grand Rapids, Mich.

Schools.
American School of Corr., Chicago, Ill.
Pratt Institute, Brooklyn, N. Y.
The International Corr. Schools, Scranton, Pa.

Screw Machinery.
Asa S. Cook Co., Hartford, Conn.

Screw Machines.
Cleveland Auto. Mch. Co., Cleveland, O.
Garvin Mch. Co., New York.
National-Acme Mfg. Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, O.

Screws.
Cleveland Cap Screw Co., Cleveland, O.

Separators, Oil.
National Separator & Mch. Co., Concord, N. H.

Shaft Hangers.
Wood's Sons, T. B., Co., Chambersburg, Pa.

Shapers.
American Tool Wks. Co., Cincinnati, O.
Cincinnati Shaper Co., Cincinnati, O.
Eberhardt Bros. Mch. Co., Newark, N. J.
Flather & Co., Nashua, N. H.
Flather, Mark, Planer Co., Nashua, N. H.
Fox Mch. Co., Grand Rapids, Mich.
Gould & Eberhardt, Newark, N. J.
Hendey Mch. Co., Torrington, Conn.
Hamilton Mch. Tool Co., Hamilton, O.
Kelly, R. A., Co., Xenia, O.
Morton Mfg. Co., Muskegon Heights, Mich.
New Haven Mfg. Co., New Haven, Conn.
Newton Mch. Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Rhodes, L. E., Hartford, Conn.
Rockford Mch. Tool Co., Rockford, Ill.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Smith & Mills, Cincinnati, O.
Springfield Mch. Tool Co., Springfield, O.
Stockbridge Mch. Co., Worcester, Mass.
Walcott & Wood Mch. Tool Co., Jackson, Mich.

Shop Boxes.
Lyon Metallic Mfg. Co., Aurora, Ill.

Slotting Machines.
Betts Mch. Co., Wilmington, Del.
Dill, T. C., Mch. Co., Philadelphia, Pa.
Garvin Mch. Co., New York.
New Haven Mfg. Co., New Haven, Conn.
Newton Mch. Tool Wks., Inc., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.

Special Machinery.
Blanchard Mch. Co., Boston, Mass.
Bliss, E. W., Co., Brooklyn, N. Y.
Dexter, Chas. S., Attleboro, Mass.
Elgin Tool Works, Elgin, Ill.
Garvin Mch. Co., New York.
National Tool Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Skinner Ship Building & Dry Dock Co., Baltimore.
Waltham Mch. Wks., Waltham, Mass.
Waterbury-Farrel Fdry. & Mch. Co., Waterbury.
Williams, White & Co., Moline, Ill.
W. A. Wilson Mch. Co., Rochester, N. Y.

Speed Changing Devices.
Evans, G. F., Newton Centre, Mass.

Stamping, Sheet Metal.
Globe Mch. & Stamping Co., Cleveland, O.

Stamps, Letters and Figures.
Schwerdtle Stamp Co., Bridgeport, Conn.

Steel.
Boker, Hermann, & Co., New York and Chicago.
Bourne-Fuller Co., Cleveland, O.
Colonial Steel Co., Pittsburg, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Heller Bros. Co., Newark, N. J.
Wm. Jessop & Sons, Ltd., New York.
National Tool Co., Cleveland, O.

Steel Castings and Forgings.
Birdsboro Steel Fdry. & Mch. Co., Birdsboro, Pa.
Hay-Budden Mfg. Co., Brooklyn, N. Y.
Wm. Jessop & Sons, Ltd., New York.

Steel Rules.
Brown & Sharpe Mfg. Co., Providence, R. I.
Keuffel & Esser Co., New York.
Lufkin Rule Co., Saginaw, Mich.

Steel Shelving, Racks, Barrels, Tables, etc.
Federal Steel Fixture Co., Chicago, Ill.

Stoppers.
McCullough-Dalzell Crucible Co., Pittsburg, Pa.

T Bolt Heads.
Lang, G. R., Co., Meadville, Pa.

Taps and Dies.
Bay State Tap & Die Co., Mansfield, Mass.
C. H. Besly & Co., Chicago, Ill.
Butterfield & Co., Derby Line, Vt.
S. W. Card Mfg. Co., Mansfield, Mass.
J. M. Carpenter Tap & Die Co., Pawtucket, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Geometric Tool Co., New Haven, Conn.
Hart Mfg. Co., Cleveland, O.

For Alphabetical Index, see Page 36.

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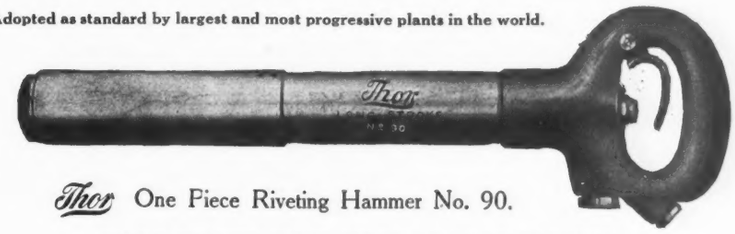

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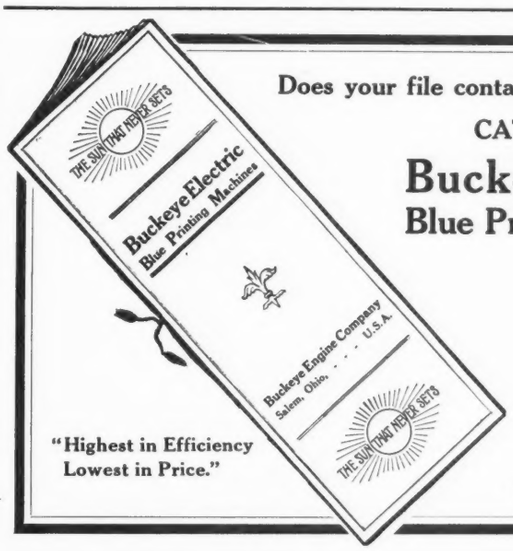
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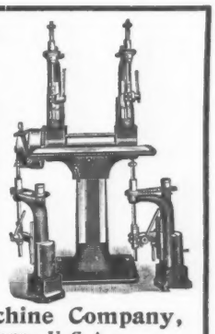

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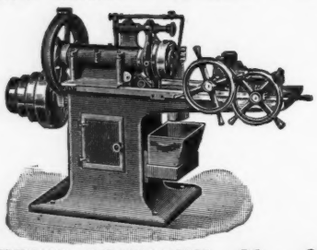

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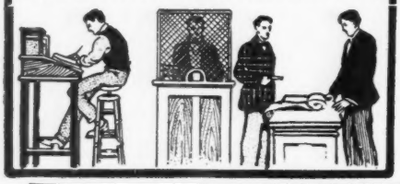

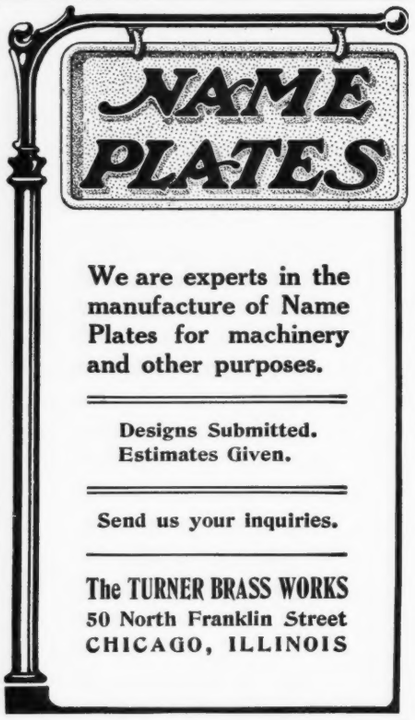

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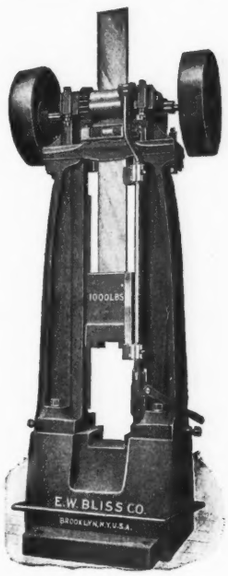

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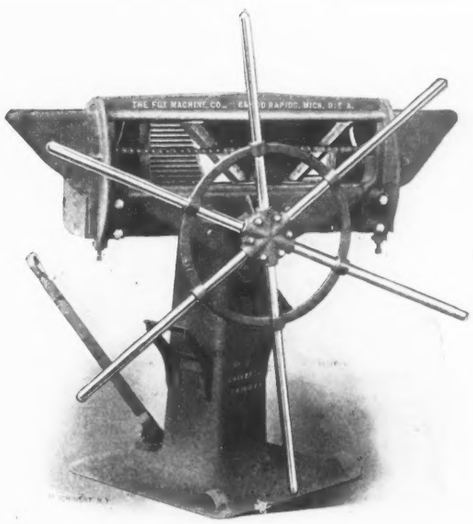

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Get the new trimmer catalog.

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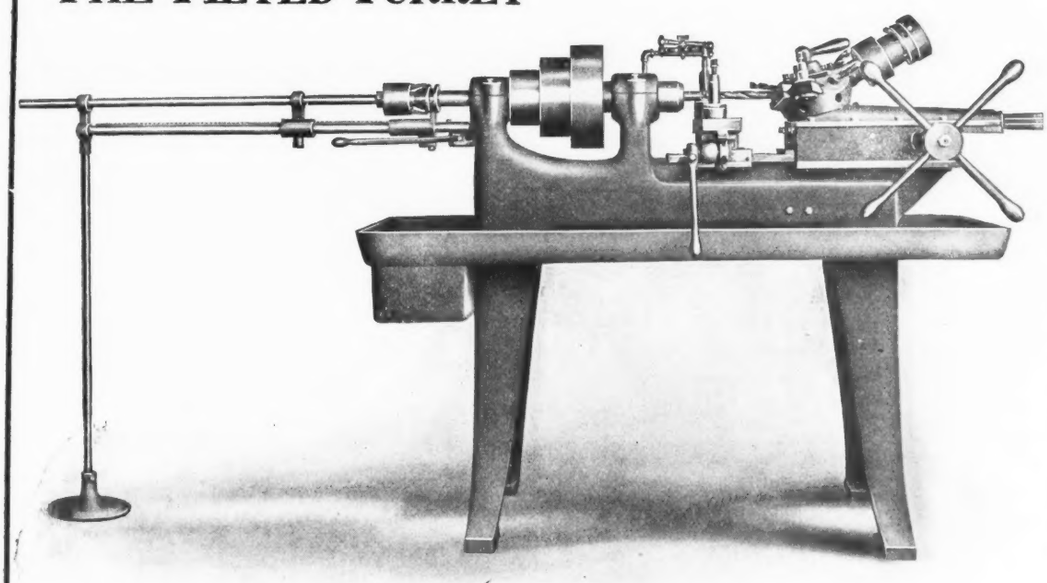

TWO UNIQUE ADVANTAGES

Note the two rows of holes in the turret.

Do you see the advantage?

The stock passes directly through the turret, thereby permitting it to be machined to any length up to the limit of the feed.

Do you notice how the die head clears the turret slide?

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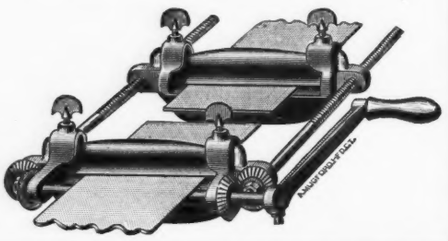
Can't slip. Why? Because its cam motion grips tighter as the belt is tightened. Belts up to 36 in. wide can be drawn together and laced while on the pulleys.



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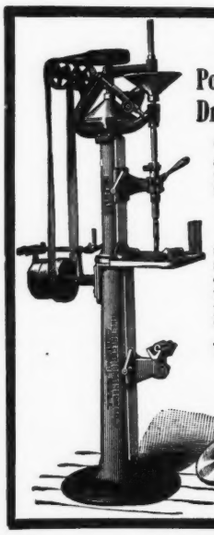

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The saving in drills alone, therefore, will more than pay for the installation of the

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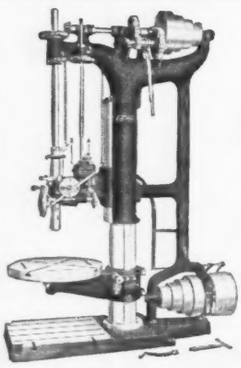

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embody every known improvement which can be used to advantage

We call particular attention to the **PATENT POSITIVE GEARED FEED** located directly on the head giving six changes of feed, each clearly indexed, all in full view of the operator, adjusted instantaneously by fixed handles, doing away with all belts and climbing to the top of the machine to make changes.

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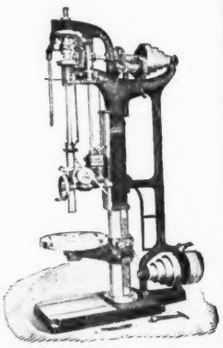

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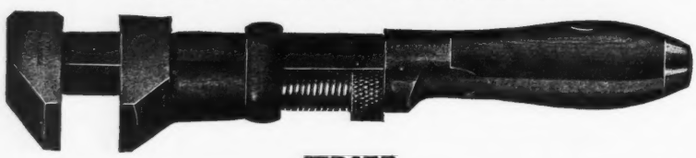

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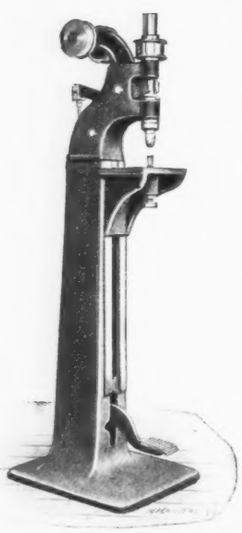

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Covers a wide range of riveting and does its work more quickly, more uniformly and with a better finish than any similar machine. Moreover, the process is perfectly noiseless; there is no blow struck, plates are not cracked or bruised, and a smooth, perfect head is swedged on the rivet shank at the rate of one each second.

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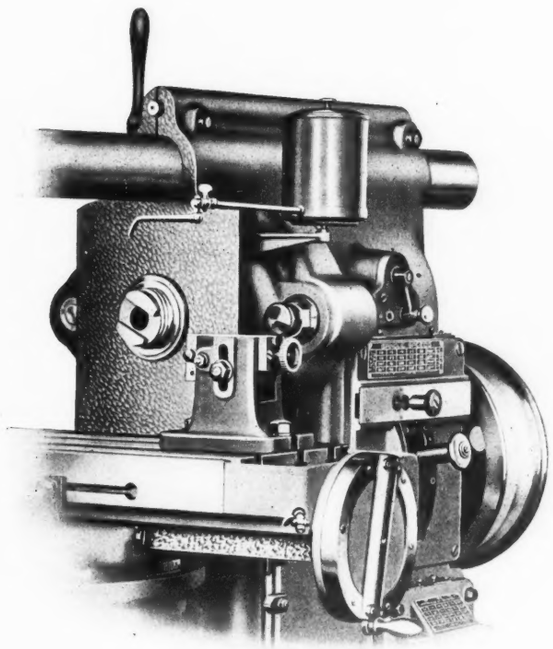
In order that an unvariable power for any given diameter of cutter on any spindle speed can be available.

How then can this Power be Obtained?



By means of a wide belt running at a high constant speed over a machine pulley of large diameter and a countershaft pulley of equal diameter. This gives large belt contact and high belt velocity, the **two requisites of Power.**

ADDITIONAL ADVANTAGES

No belts to shift. All changes of spindle speed made at the side of the machine by the simple adjustment of index slide and lever. Feeds independent of spindle speeds.

Detailed description and specifications of any of the Constant Speed Drive Milling Machines sent upon application.

MASTER BLACKSMITHS' ASSOCIATION CONVENTION.

The fifteenth annual convention of the International Railroad Master Blacksmiths' Association will be held at Bath Hotel, Montreal, Canada, August 20 to 22, inclusive. The subjects are: Flue Welding, John Connors, chairman; Tools and Formers for Bulldozers and Steam Hammers, G. M. Stewart, chairman; Piece Work, Grant Bollinger, chairman; Discipline and Classification of Work, S. Uren, chairman; Case-hardening Methods, Time Taken and Samples, Geo. Masser, chairman; Best Fuel for Use in Smith Shop, Joseph Jordon, chairman; Frame Making, Either Steel or Iron, Also Repairing Same, Grant Bollinger, chairman; Thermit Welding, Geo. Kelly, chairman; What Can Each Member do to Increase the Usefulness of the Association, G. F. Hinkens, chairman.

* * *

FRESH FROM THE PRESS.

PROCEEDINGS OF THE AMERICAN WATER WORKS ASSOCIATION at the 26th annual convention held at Boston, Mass., July, 1906. 669 pages, 6 x 9 inches. Published by the secretary, John M. Diven, Charleston, S. C.

AN INVESTIGATION OF THE BORIDES AND SILICIDES. By Oliver P. Watts. 68 pages, 6 x 9 inches. Five pages of bibliography. Published by the University of Wisconsin, Madison, Wis. Price, 30 cents.

LOCOMOTIVE DATA. 90 pages, 3 x 5 inches, illustrated. Published by Burnham, Williams & Co., Philadelphia, Pa.

This little booklet, issued in the interest of the Baldwin Locomotive Works, gives in condensed form much valuable information on locomotives. The system of locomotive classification used by the Baldwin Locomotive Works is explained. The booklet contains diagrams of train resistance formula, grade resistance, curve resistance, tractive power of locomotives, both simple and compound, useful tables, etc.

PRECISION GRINDING. By H. Darbyshire. 162 pages, 5½ x 8½ inches. 39 cuts. Published in the United States by the Hill Publishing Co., New York. Price, $2.

The work treats of the advantages of grinding, grinding wheels and their manufacture, methods of grinding compared, economy of grinding wheels and quality of finish, causes of defective work, the preparation of work for the grinding machine, plain cylindrical grinding, the universal head, plain surface grinding, cutter grinding, laps and lapping, measuring tools and gages, etc. The work is one that should be welcomed by the grinding machine operators and all who have to do with the use of the grinding machine.

EFFECT OF SCALE ON TRANSMISSION OF HEAT THROUGH LOCOMOTIVE BOILER TUBES. By Edward C. Schmidt and John N. Snodgrass. 24 pages, 6 x 9 inches, illustrated. Published by the University of Illinois, Urbana, Ill.

This bulletin is No. 11, issued by the Engineering Experiment Station of the University of Illinois, and is an account of tests, extending over a period of years, made to determine the effect of scale on the transmission of heat in locomotive boilers, especially through the tube walls. These tests show that the effect of scale on heat transmission is extremely variable, and that it has been largely over-estimated in many cases. The tests show that the character of the scale is all-important and that mere thickness is not a measure of effect. The general conclusions are that with various thickness of scale up to ⅛ inch the loss in heat transmission may vary in individual cases from insignificant amounts to as much as 10 or 12 per cent; that the loss increases somewhat with the thickness of the scale; the mechanical structure of the scale is of as much or more importance than the thickness in affecting heat transmission; and that the chemical composition of the scale, except in so far as it affects the structure of the scale, has no direct influence on its heat-transmitting qualities.

NEW TRADE LITERATURE.

THE UNITED STATES ELECTRICAL TOOL CO., Cincinnati, O. Catalogue of portable electrical tools, illustrating and giving specifications for portable drills, grinders, etc.

THE HERMAN PNEUMATIC MACHINE CO., Zelienople, Pa. Catalogue of pneumatic molding machines, rotary sand sifters, pneumatic equipment for factories, etc.

EMMERT MFG. CO., Waynesboro, Pa. Catalogue No. 7, describing and illustrating Emmert patent universal vises. A price list for the different sizes is included.

FRANKLIN MFG. CO., 203 So. Geddes St., Syracuse, N. Y. Booklet entitled "Franklin Castings," describing the Franklin die cast process of producing small finished castings. A number of different styles of finished castings made by this method are illustrated.

LUMEN BEARING CO., Buffalo, N. Y. Illustrated catalogue containing a comprehensive statement regarding the standard alloys produced by this company, the conditions under which they work most advantageously, and their limitations.

NILES-BEMENT-POND CO., Trinity Building, 111 Broadway, New York City, in its *Progress Reporter* for July, 1907, gives information regarding the Pratt & Whitney 2 x 26 open turret lathe, 10-foot double rotary planing machine, Pratt & Whitney automatic grinding machines, Niles gantry crane, etc.

TARIFF SERIES No. 3, being "Tariff on Machinery, Machine Tools and Vehicles," issued by the Department of Commerce and Labor, Washington, D. C. This compilation gives the tariff schedules of all countries imposing import duties on machinery, machine tools and vehicles.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Pamphlet entitled "Thermit Steel for Welding," being an illustrated description of the thermit process for repairing broken parts of machinery. Several interesting examples of work repaired by thermit are illustrated and described.

NORTON CO., Worcester, Mass. New 1907 edition of catalogue on Grinding Wheels and Machinery. This catalogue supersedes all previous editions and contains a comprehensive description of the products of the company. It also includes an account of the testing of the wheels, before shipment.

THE R. K. LE BLOND MACHINE TOOL CO., 4605 Eastern Ave., Cincinnati, O. Catalogues on 20-inch High Speed Lathes, 24-inch High Speed Engine Lathe and Reducing Lathe, and Le Blond Turret Lathes and Equipments, respectively. These catalogues contain illustrations, specifications and general descriptions of the various types of these lathes.

BROWN & SHARPE MFG. CO., Providence, R. I. Booklet of gears, castings, and pumps, compiled with special reference to the needs of automobile manufacture. It illustrates hardened gears and various other varieties of gears for motor vehicle construction. The company makes gray iron castings, peculiarly well suited for air-cooled and water-cooled automobile cylinders.

GOLDSCHMIDT THERMIT CO., 90 West St., New York. Pamphlet describing fire-brick molds for welding locomotive frames by the thermit process. These molds are now made in a variety of shapes to fit various parts of locomotive frames liable to fracture, and their use considerably simplifies the thermit process, as it eliminates much of the preliminary work in preparing a mold, which was necessary before.

AMERICAN SPIRAL PIPE WORKS, Chicago, Ill. Catalogue of forged steel flanges, said to be the most complete work of its kind ever published on the subject. It contains illustrations of full size cross-sections of extra heavy hub flanges, extra heavy companion flanges, standard companion flanges, welding flanges, boiler flanges, tank flanges, riveted pipe flanges, A. S. M. E. standard riveted pipe flanges, riveted pipe manufacturers' standard; and the dimensions of extra heavy boiler flanges, double riveting boiler flanges, etc.

INGERSOLL-RAND CO., 11 Broadway, New York City. Bulletin on "Crown" Pneumatic Hammers. These hammers are fully described, each detail of construction being shown, and every operation given attention. The design of the hammer is new and the construction simple. Five sizes of hammers are made for chipping, calking, scaling, flue-beading, etc., and four sizes, long stroke, for driving rivets from the smallest up to 1¾-inch diameter. The bulletin also describes a displacement air meter, by which the performances of these tools have been tested and verified.

UNION TWIST DRILL CO., Athol, Mass. Illustrated book of information on gear and milling cutters. Cutters for gear wheels, twist drills, taps, reamers and formed cutters, which can be sharpened without changing the form, are listed; also milling cutters, metal slitting saws, angular cutters, end mills, screw slotting cutters, inserted tooth cutters, etc. The book contains full-size diagrams of involute gear teeth from 20 diametral pitch to 1 diametral pitch, inclusive, formulas in gearing, valuable tables, directions for grinding cutters, etc. Mechanics will find it an indispensable work of reference for the machine shop.

THE MCCONWAY & TORLEY CO., Pittsburg, Pa. Pamphlet entitled "Car Repairman's Guide," being a list of the repair parts required for the Janney, Kelso and Pitt freight couplers, and the Buhoup three-stem equipment for passenger cars. The company calls the attention of railway officials to the desirability of ordering repair parts from the manufacturer of the used couplers. A great deal of unnecessary trouble and delay in making repairs is caused by attempts to use repair parts that were not made by the manufacturer, and which are frequently incorrect to pattern and inferior in material or workmanship. The object of this pamphlet is to place definite information in the hands of the men so that the proper repair parts may be secured.

MANUFACTURERS' NOTES.

BROWN & SHARPE MFG. CO., Providence, R. I., will close its works for the regular annual vacation from August 2 to August 12. During the vacation the offices will be open as usual.

THE PITTSBURG AUTOMATIC VISE AND TOOL CO., Pittsburg, Pa., recently shipped a number of the largest vises ever constructed to the Portsmouth Navy Yard, N. H. These vises weigh 695 pounds each, and are specially designed for heavy and severe service.

CARNEGIE TECHNICAL SCHOOLS, Pittsburg, Pa., report that their department of mechanical engineering practice is starting a catalogue file, and they request manufacturers to send their catalogues in care of Prof. Trinks. Complete information is desired on all lines of mechanical work, from boilers and engines to automatic and special machinery.

THE AUTOMATIC MACHINE CO., Bridgeport, Conn., which intends to treble the capacity of its various departments within the next six months, will need an assistant general manager, assistant superintendent of works, treasurer, chief accountant, office manager, purchasing agent, mechanical engineer, shipping and store clerk, and five foremen.

INDEPENDENT PNEUMATIC TOOL CO., First National Bank Building, Chicago, Ill., reports that its business has shown a remarkable increase over the corresponding period of last year. Its Aurora, Ill., plant has been enlarged, the capacity being increased about 50 per cent. The plant is now running in full operation day and night, and sufficient orders are on hand to keep the plant running for several months.

CROCKER-WHEELER CO., Ampere, N. J., announces that on account of the large volume of business in electric generators and motors in southern Ohio, it has been found necessary for the Cleveland office to open a sub-office in the Columbus Savings and Trust Co. building, Columbus, Ohio. The sub-office will be in charge of Charles W. Cross, formerly of the Cleveland office.

THE CINCINNATI PLANER CO., Cincinnati, O., has increased its capital stock from $200,000 to $400,000. The additional capital will be used to cover the cost of the new plant now being built at Oakley, Ohio, which is a suburb of Cincinnati. This plant will be equipped complete with new machinery, and will be operated exclusively on large planers from 6 to 12 feet square. The company will continue to operate its present plant on the smaller sizes. The new Oakley plant is now well under way, and will be completed some time in September.

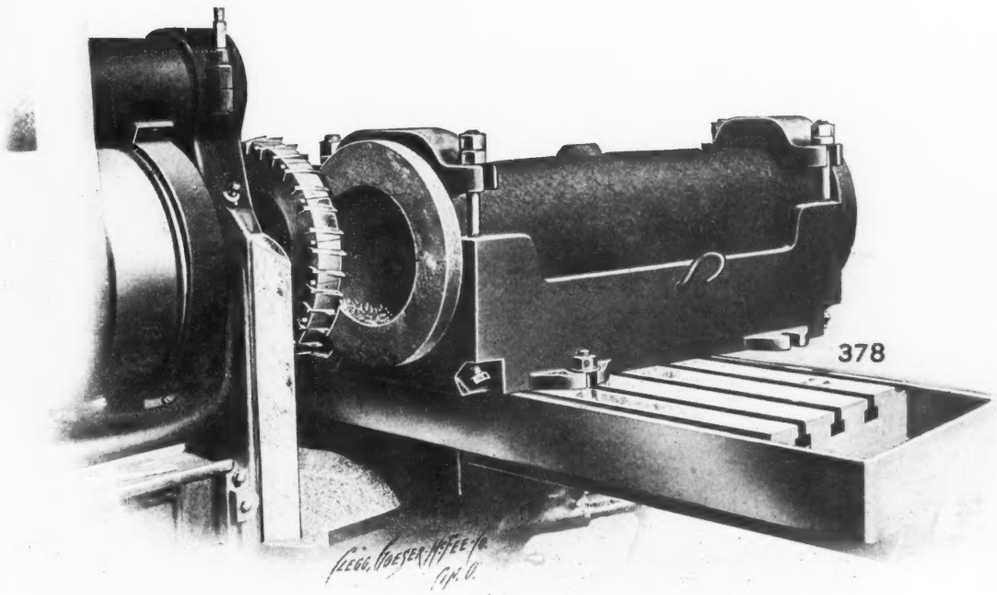
LUMEN BEARING COMPANY, Buffalo, N. Y., is erecting a two-story building 125 x 30 feet, to be used for the storage and manufacturing of wooden patterns, and as a carpenter shop. This building is connected by a passageway with the main foundry, and is of fireproof construction, steel and concrete only being used. The windows are of wire glass and the door cases are made of pressed steel. This addition will greatly facilitate the company's work, as it gives them a storage capacity for 50,000 patterns of the ordinary run for brass foundry work.

A new engineering society has been organized in Philadelphia called The Engineers' and Constructors' Club. The membership is limited to the engineers composing the organization of Dodge & Day. The officers are Harold T. Moore, president; George Walters, secretary; F. C. Andrews, H. F. Sanville, John E. Zimmerman, C. N. Lauer, managers. The object of the club is to discuss subjects relating to engineering and construction, and to give all the members the benefit of the experience gained by each in his particular line of work. The proceedings of the club will be published regularly.

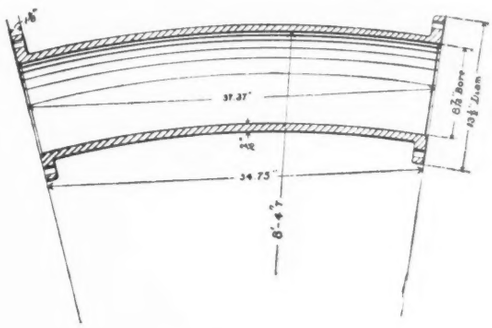
AMERICAN BLOWER CO., Detroit, Mich., made an exhibit at the recent Atlantic City convention of the Master Mechanics and Master Car Builders Associations, which attracted much attention. It consisted of an American high-pressure blower in operation, emitting from the discharge a blast of air at high velocity, which held suspended about four feet above the outlet a ball of 12 inches diameter. Just why the ball remained at that point instead of flying off into the ocean was a question that puzzled the crowd. Those who are interested in the answer should write the company for an explanation.

BARNES DRILL CO., Rockford, Ill., has been organized for the manufacture of up-to-date upright drills and gang drills of high grade, with the following officers: B. F. Barnes, president; D. J. Stewart,

Flanges of Curved Pipe Sections



Are milled by the Blanchard Machine Company, Cambridge, Massachusetts, on a No. 4, PLAIN CINCINNATI MILLER as shown above. The pipe is made of close, hard grey iron. This section is 8 ft. 4 in. radius, has flanges 13-½″ diameter; the depth of cut is 3-16″. The cutter is 14″ diameter, makes fifteen revolutions per minute—feed .134″—table travel 2″ per minute on the roughing cut. For finishing the feed is reversed, counter shaft shifted to fast speed, twenty-six revolutions per minute, table travel, 3½″ per minute, producing a smooth cut, satisfactory for an air-tight leaded joint. The pieces are brought exactly to gauge.



Total time for chucking and milling one piece complete, fifty-five minutes.

How would you do such work?

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vice-president; J. E. Andress, secretary; M. A. Love, treasurer. The company has rented about 23,000 square feet of space in the old Emerson plant, but, as soon as its new line of tools is on the market, it expects to build a new plant, modern in all respects to suit the needs of machine tool manufacturing. The rented plant will be fitted out with modern equipment, all the heavier machines to be motor-driven and self-contained. The company is in the market for a complete line of small tools, such as are necessary for a machine shop.

THE new Machinery Club, organized in New York by those interested in the various branches of the machinery and metal trades, is making satisfactory progress, and has engaged quarters on the 20th and 21st floors of the Fulton Terminal Building, on Church St. The space provided for the club is 36,000 square feet, and there is a possibility that the 19th floor of the building also will be reserved, in which case the total area available will be 54,000 square feet. The organization will be primarily a lunch club, but it is expected that the conveniences of the location and the home-like appointments will make it a general rendezvous of the machinery trade in New York. Resident membership will be limited to 750, and will consist of members residing in Manhattan or having a regular office there. The suburban membership will be limited to 500, and will be confined to those having a regular office outside of Manhattan, but within fifteen miles of New York City Hall. The non-resident members, limited to 1,000, will be those residing or having a regular office outside of the suburban membership limits. No limit is placed on the number of commissioned officers of the Army and Navy, either active or retired. The membership committee is J. R. Vandyck, chairman; George L. Gillen and Charles H. Crook. The temporary quarters of the Machinery Club are at 26 Cortlandt St., New York.

MISCELLANEOUS.

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

ADVICE.—Mechanical, both Practical and Technical. Tell me your needs; I'll tell you the cost. Results or no fee. JOS. V. WOODWORTH, M.E., Arbuckle Building, Brooklyn, N. Y., U. S. A.

A MANUFACTURING COMPANY long established can show 300 per cent increase now, are looking for the following men: Assistant General Manager, Superintendent of Works, Secretary, Treasurer and Chief Accountant, Office Manager, Assistant Superintendent, Purchasing Agent, Mechanical Engineer, Shipping and Receiving Clerk, Foremen, etc. Persons who are capable of filling these positions and who can invest from $2,000 to $20,000, please communicate to P. O. Box No. 725, Bridgeport, Conn.

AMONG THE FIRMS who rely upon us to supply them with high grade men are many of the leading technical employers of the country. Some of them need men *now* for responsible positions, salary $1,000-$5,000; service strictly confidential. Write us to-day. HAPGOODS, 305 Broadway, New York.

ARE YOU MAKING $25 to $30 PER WEEK? Be a draftsman. Mechanical and Structural Drawing taught by experts. Graduates in demand. Low tuition, including Free Books, Drawing Instruments, Lectures, etc. Send for circular. COLUMBIA CORRESPONDENCE SCHOOL, Drexel Building, Philadelphia, Pa.

DETAIL DRAFTSMAN.—One who has had experience on machine tool work preferred. Preference also given Swedish, Danish or Norwegian technical graduates. State whether married or single, age, experience and salary expected. Address Box 135, care MACHINERY, 49-55 Lafayette St., New York.

DRAFTSMAN.—Mechanical, wants position; experienced on high-class automatic machinery, or as assistant superintendent. References. "J. P. H.," care MACHINERY, 49-55 Lafayette St., New York.

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DRAFTSMEN AND TOOLMAKERS.—Draftsmen on mill construction, $25-$30 per week. Toolmakers on small tools, 37½ cents per hour. Five punch and die makers, 40 cents per hour. MACGREGOR'S ENGINEERING AGENCY, Springfield, Mass.

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PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F Street, Washington, D. C. Established 1883. I make an examination free of charge, and report if a patent can be had and exactly how much it will cost. Send for circular. Member of Patent Law Association.

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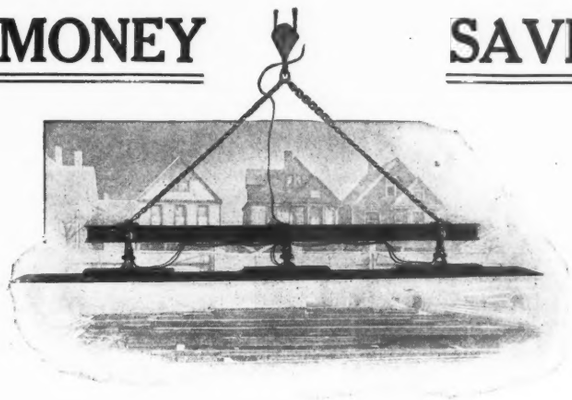
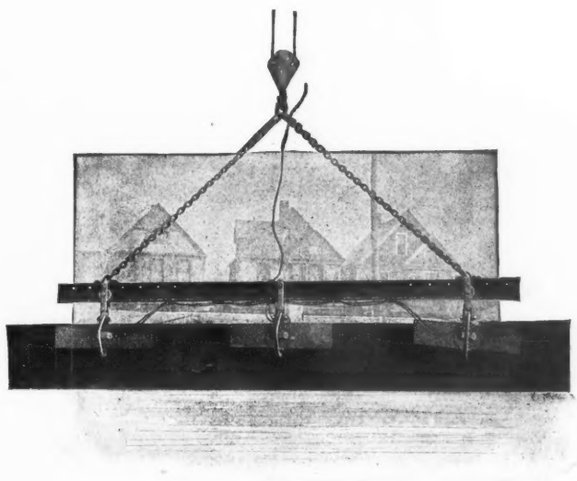
Equipments of this type have also demonstrated their value in unloading plates from a horizontal position in a car and transferring them to a vertical position in stocking racks.





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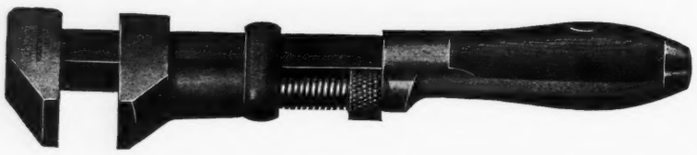

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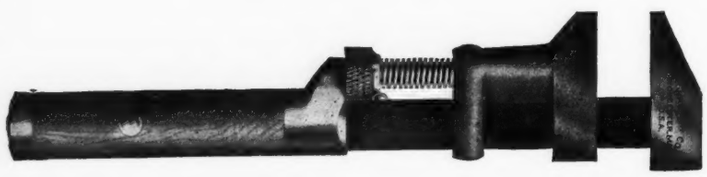

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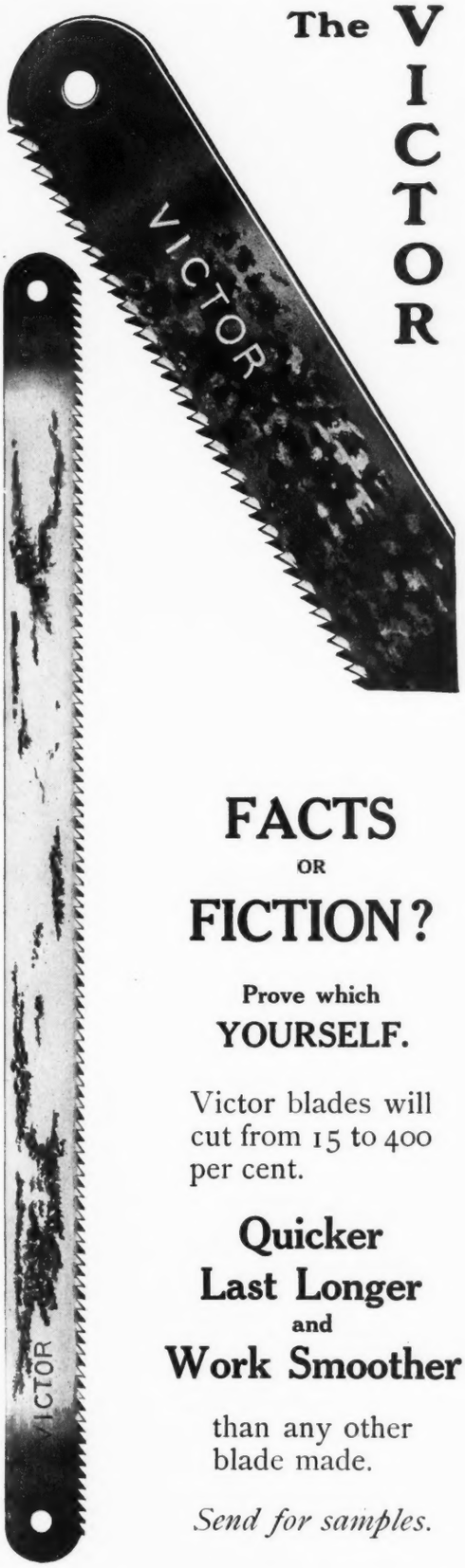

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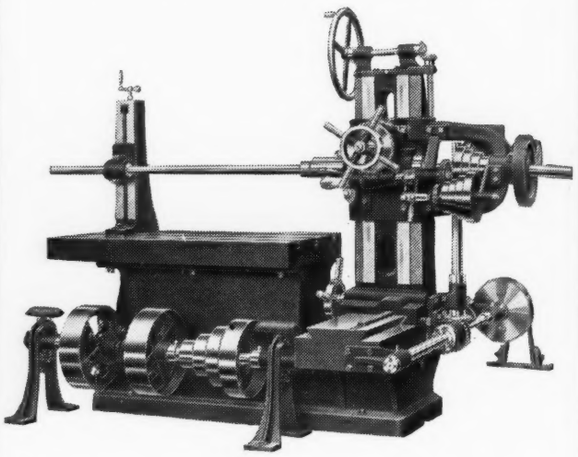

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It is very rigidly built and strongly geared for heavy work.
Spindle is 2 1-16 inches in diameter and has 19 inches travel.
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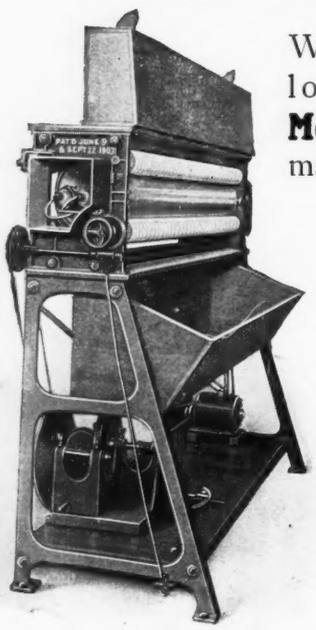
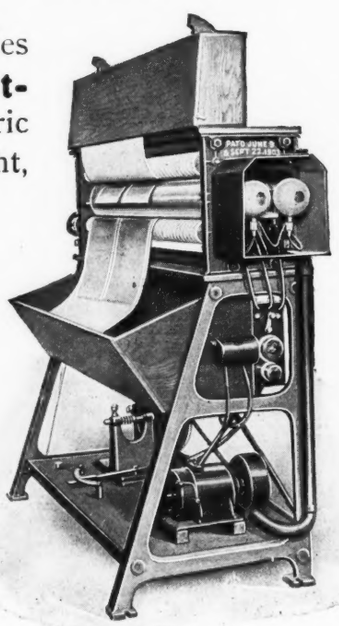


We make them two miles long on the **Everett-McAdam** continuous electric machine. Prints day or night, always ready, quick printing, perfect prints, small cost.

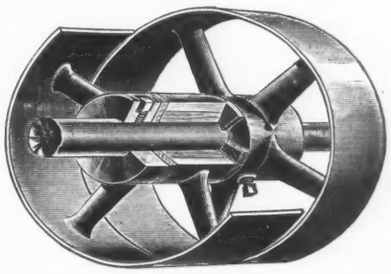
See long list of users in July issue of MACHINERY.



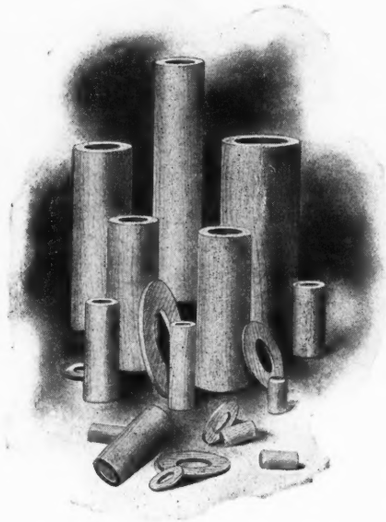
REVOLUTE MACHINE COMPANY, 518 West 45th Street, N. Y. City

ONE of the meanest of Machinery Problems is how to Lubricate the Loose pulleys.

It has to be done, yet oil won't stay at the center of a rapid running loose pulley—it's thrown off as quick, or quicker than you can put it on, and then there's all kinds of trouble.



Loose Pulley Equipment
PATENTED



Standard Cylindrical Bushings and Thrust Washers

Arguto Oilless Bearings

permit loose pulleys and friction clutches to be run absolutely without oil or other lubricant. They are the *solution of the problem*, wear indefinitely, require no attention and have proved their worth in the largest and most progressive plants in the country. Arguto Oilless Bearings will eventually be specified with every order for loose pulleys or friction clutches—why not get in line now? *Booklet for the asking.*

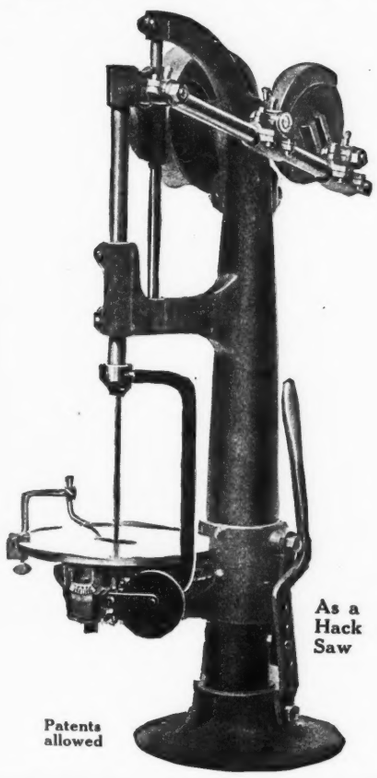
ARGUTO OILLESS BEARING COMPANY

WAYNE JUNCTION, PHILADELPHIA, PA.

See our Exhibit, Section 6, Machinery and Transportation Building, Jamestown Exposition.

"Arguto"
TRADE MARK
Reg. U. S. Pat. Of.

Can You File a Blanking Die



Patents allowed

As a Hack Saw

by hand with ONE DEGREE of clearance and have it so accurate that the blanks will fall out as soon as they are cut free?

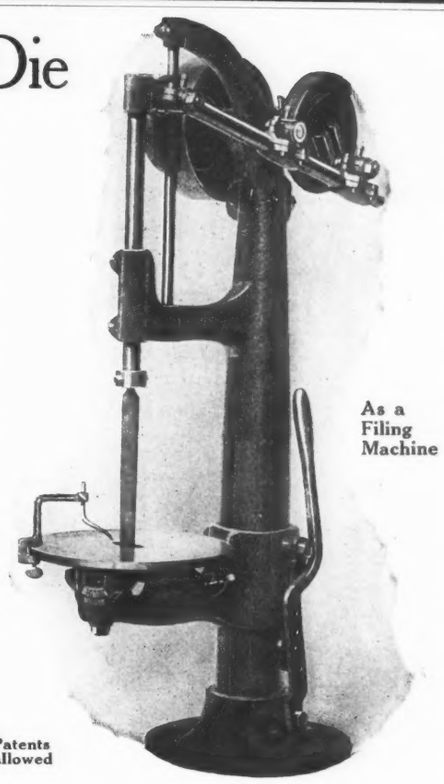
We are doing it with the "SIMPLEX" Filing Machine, and in ONE-HALF the time required to file dies with x degrees of clearance by hand.

The "ONE DEGREE" die can be ground repeatedly—

How many times can the ordinary hand filed die be ground?

Consider this matter. It means DOLLARS TO YOU, both in first cost of dies and in their increased life.

We shall be glad to send a list of firms who "have discovered" the Simplex Combination Bench Filer and Hack Saw, if you will let us know your address.



As a Filing Machine

Patents allowed

The Simplex Manufacturing Company

90 WEST STREET, NEW YORK CITY

The importance of grinding has multiplied within the last few years.
In the old days grinding operations were limited chiefly to taking off the rough of castings, polishing, sharpening tools, etc.
The grinding wheels of fifteen years ago were not good enough to do more than that—
But there was a demand for something better—
And

CARBORUNDUM

came along to meet it. Carborundum is the ideal abrasive—as superior to emery and corundum and other old time abrasives as they were superior to the grindstone of still earlier days.
Carborundum has revolutionized grinding, and today hundreds of operations that were formerly done with steel tools are being done faster, better and more economically by Carborundum grinding wheels.
The reason for it all is that Carborundum is very sharp and very hard—
It doesn't really grind at all—it cuts—
And it cuts so fast and lasts so long that it is immeasurably more economical than any other abrasive wheel ever produced.

Let us send you the book
"The man who didn't know
when he had failed."

The Carborundum Company

Niagara Falls, N. Y.

The Advantage is Yours

By adopting the Graham Chuck and the Graham Grooved Shank System of tools you stand to save 10% per cent. in time and 100% on your chuck bill. Isn't this an advantage?

The Graham Chuck

holds the tools so there is no danger of slipping or working loose. A single turn of the sleeve tightens or releases the tool—no wrench, screw or hammer required. It is strong and durable, can be made to fit the spindle of any drill press or lathe, and one chuck, with reducers, holds a complete range of sizes from 3/32" to 2½"—drills, taps, reamers, etc.

New Catalogue on request

Detroit Twist Drill Co.
630-646 Fort Street, West
DETROIT, MICH.
Manufacturers of all kinds of Twist Drills, Reamers and Special Tools

THERE'S A PLACE FOR THIS DRILL IN YOUR SHOP

The design is new. All improvements incorporated. Drills to the center of a 21-inch circle and is quick and accurate in operation.

We shall be glad to send you a special circular of the 21-inch Back Gear Power Feed Drill if you will write us.

SUPERIOR MACHINE TOOL CO.
Kokomo, Indiana

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THE BEST BEARING METAL FOR ALL PURPOSES

GLYCO

CHEAPER AND BETTER
THAN THE HIGH PRICED TIN ALLOYS

HOMOGENEOUS
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A LARGE STOCK ALWAYS ON HAND FOR IMMEDIATE SHIPMENT

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SOLE MANUFACTURERS IN AMERICA OF
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JOSEPH T. RYERSON & SON
CHICAGO NEW YORK PITTSBURG
GENERAL DISTRIBUTORS

THE FIRST ELEVEN

5,000 SETS READY FOR MAILING

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Data Sheet No. 1—September, 1898.
Spur gears: Diametral pitch; circular pitch diameter; outside diameter; pitch circumference; thickness of tooth; clearance; addendum, etc.
Laying out blanks for bevel gears.
Worm gearing practice: Involute tooth; lead; face; pitch; throat; diametral pitch; angle of tooth, etc.
Diagram: Allowances for force, drive and running fits.

Data Sheet No. 2—December, 1898.
Tables: Morse tapers; standard pins; Brown & Sharpe tapers; tapers per foot and corresponding angles; standard hexagon heads and nuts.
Tables: Tap drills; machine screws; wrought-iron pipe; twist drill and steel wire gage; taper of pipe thread.
Tables: Decimal equivalents, 4ths, 8ths, 16ths and 64ths of an inch; decimal equivalents 3ds, 6ths, 12ths and 24ths of an inch; decimal equivalents, 7ths, 14ths and 28ths of an inch; depth of space and thickness of tooth of spur gears when cut with Brown & Sharpe cutters.
Tables: Wire gages in common use; letter size drills.

Data Sheet No. 3—March, 1899.
Formulas for strength and deflection of common springs.
Table: Strength of materials.
Formulas and constants for loaded beams, etc.

Data Sheet No. 4—June, 1899.
Table: Decimal equivalents of millimeters.
Table: Equivalents of inches in millimeters.
Tables: Decimal equivalents of fractions of millimeters, metric conversion.

Data Sheet No. 5—September, 1899.
Mechanics: Motion; center of gravity; moments of inertia; radius of gyration; work; momentum; energy; centrifugal force; compound pendulum; friction.

Data Sheet No. 6—January, 1900.
Mechanics (continued): Moments; safety valves; scale beams; principle of work; Prony brake; tackle block; strap brake; epicyclic gear; ratio of pulleys; crank and connecting rod; toggle joint; differential pulley; parallelogram of forces; catenary curve or suspended cable; friction clutch; triangle of forces; polygon of forces; stresses in crane.

Data Sheet No. 7—March, 1900.
Diagram: Horse power transmitted by leather belt per inch of width.
Diagrams: Strength of gear teeth; belt transmission; strength of gears.
Tables: Horse power of shafting and working proportions for shafting of medium steel; horse power transmitted by ropes.

Data Sheet No. 8—September, 1900.
Table: Surface speed in feet per minute from ¼ inch to 10 feet diameter; revotions 5 to 500 per minute.
Tables: Lathe work; screw machine practice; milling cutter speeds.
Tables: Drilling speeds; lubricants for cutting tools.

Data Sheet No. 9—March, 1901.
Table: Tapers per foot and corresponding angles; measurement of tapers.
Table: U. S. Standard screw threads and formulas.
Table: Standard metric screw threads and formulas.

Data Sheet No. 10—June, 1901.
Change gears for the engine lathe; single and compound gearing.
Taper turning; speed of pulleys and gears.
Use of index centers on the milling machine.
Change gears for cutting spirals on the milling machine.

Data Sheet No. 11—September, 1901.
Grant's odontograph; cycloidal and involute systems.
Table: U. S. Standard bolts and nuts.
Formulas for laying out bevel and miter gear blanks.

There must be not less than 30,000 MACHINERY readers, past and present, whose sets of data sheets are complete with the exception of the first eleven in the series; and they will be glad to learn that these can now be obtained for the first time in nearly three years. New plates have been made and a very large edition printed, so that for the first time in three years we are able to offer the complete set of Data Sheets, not only from No. 1 to 11, but also from No. 1 to 61, without a break.

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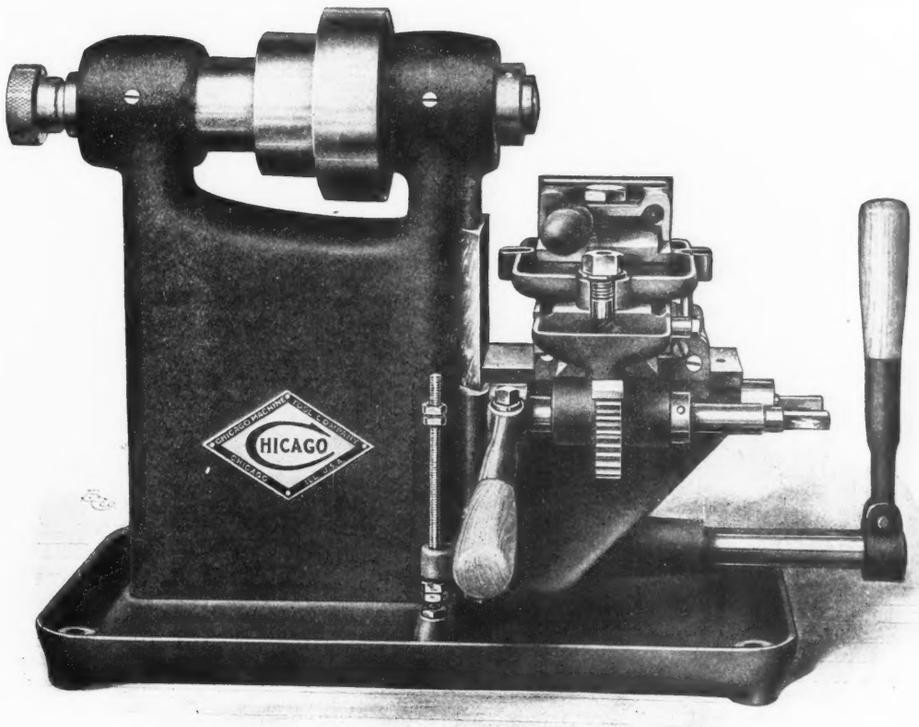
The Industrial Press

Publishers of MACHINERY

49-55 Lafayette Street, New York City

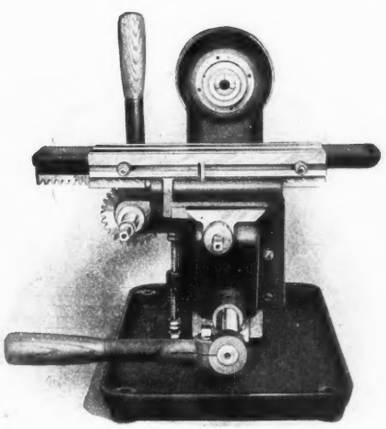
New Bench Milling Machine

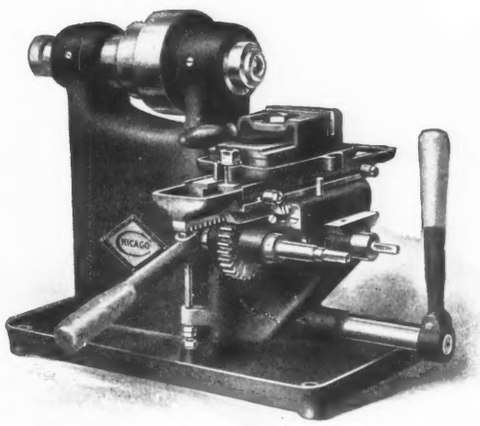


We are pleased to call your attention to these different views of our New Bench Miller

The Chicago Machine Tool Company

CHICAGO, ILLINOIS





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We are pleased to announce that

Our New File Works

are in perfect working order,
and their constantly increasing output of

"American Swiss" Files

will enable us to abolish the Waiting Lists
and fill orders promptly.

Our Salesmen

whose traveling expenses we pay with pleasure,
because they always talk to the point,
are
Sample Packages of Six Files,
and our Price List with Discounts.

Your permission to send you one of these quiet, modest,
unpretentious but efficient Salesmen
will much oblige,

E. P. Reichhelm & Co.

Principal Owners and Selling Agents of the American Swiss File and Tool Co.

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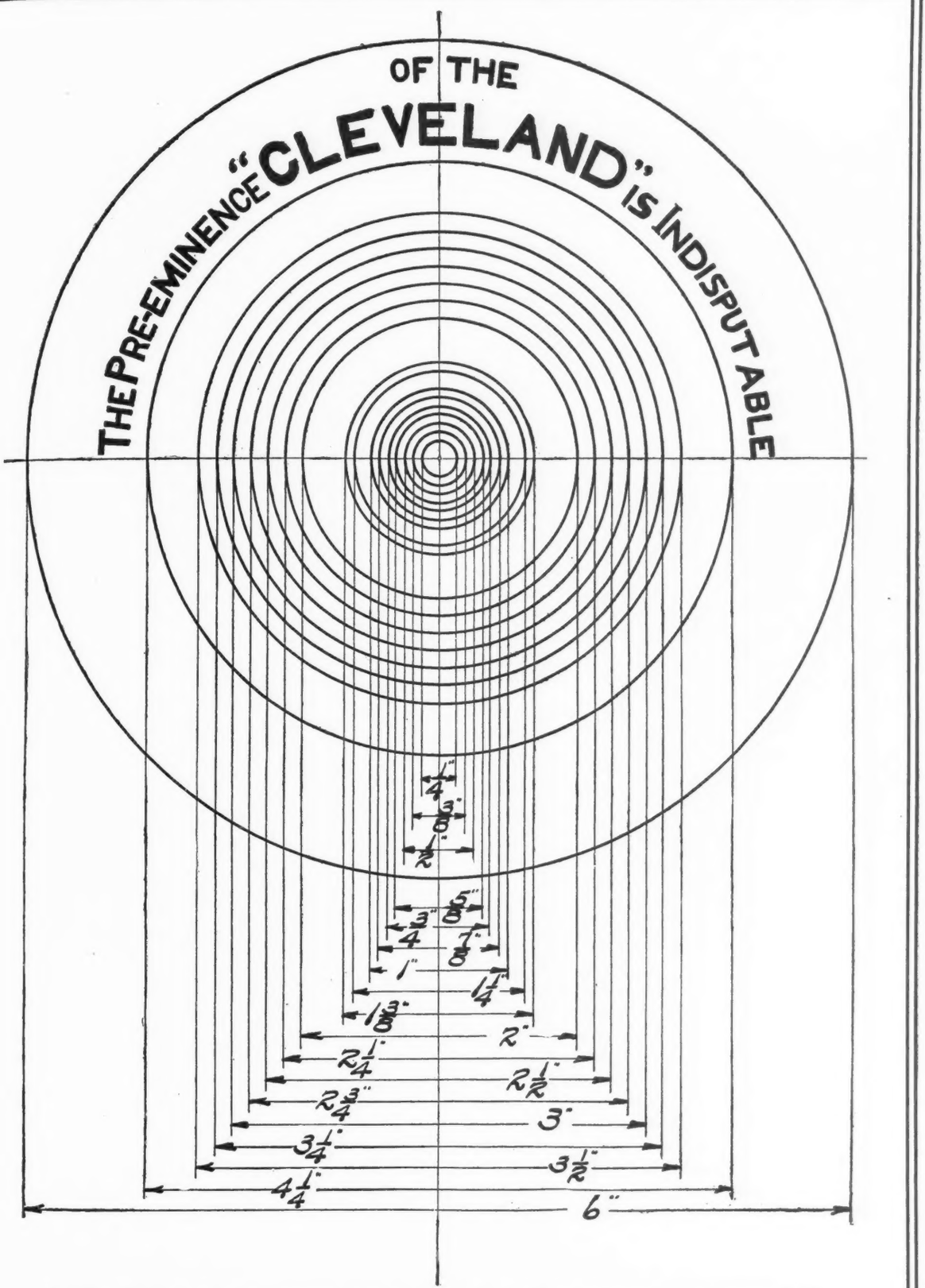

Each circle represents the size of a Cleveland. We make parts from bars weighing from 1 ounce to 1000 pounds.

Cleveland Automatic Machine Co., Cleveland, Ohio, U. S. A.

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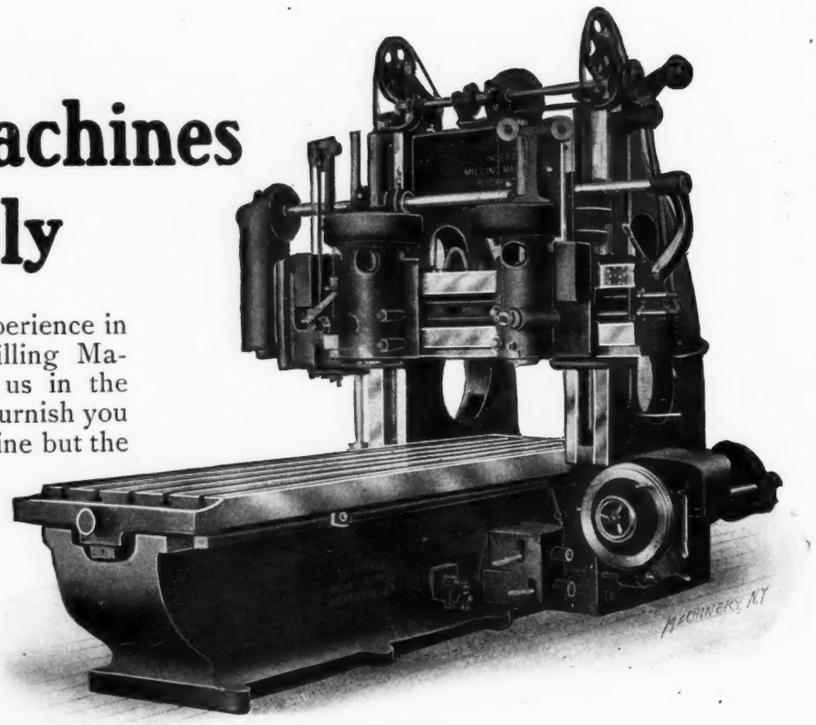
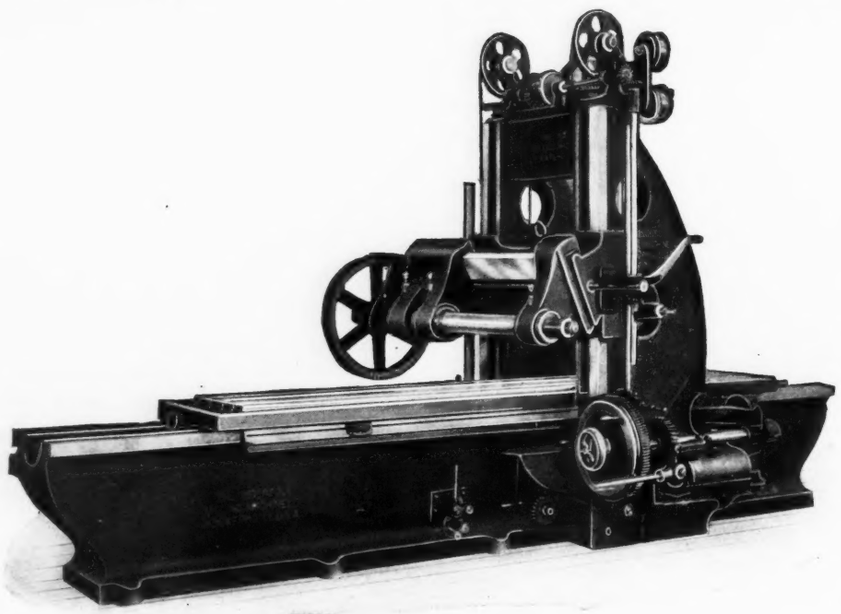
Heavy Milling Machines Exclusively

"Our twenty years' experience in building Heavy Type Milling Machines certainly has put us in the front rank, so that we can furnish you not only a first-class machine but the very best. All sizes and types, suitable for the very lightest automobile aluminum gear cases, up to the heaviest kind of work found in any large machine shop."



48-inch Double Vertical Spindle Milling Machine.

One, Two, Three or Four Spindle arranged any way to suit requirements.



Standard Horizontal Type All Sizes

This Horizontal Machine with our Vertical Spindle Attachment covers a wide range of work.

The Ingersoll Milling Machine Company

ROCKFORD, ILLINOIS, U. S. A.

Eastern Branch, 114 Liberty Street, New York, Walter H. Foster, Mgr.

TRADE-MARK.

No. 62,316. REGISTERED APR. 30, 1907.

NEWTON MACHINE TOOL WORKS INCORPORATED.

CERTAIN MACHINERY.

APPLICATION FILED APR. 26, 1906.

NEWTON

Witnesses:-
Wills A Burrows
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Proprietors.-
Newton Machine Tool Works,
Incorporated, by its Attorneys;
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QUALITY

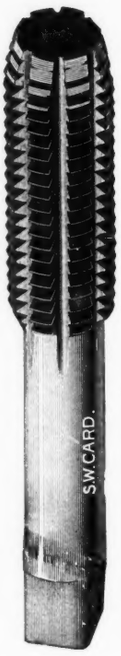
in your Taps, Dies, Screw Plates, etc.

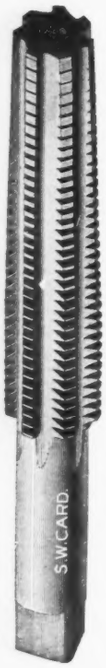
Specify Card Tools

A Card Tap will outwear and outwork any tool of its class. It is true to size and pitch, produces accurate work and can be relied on.

Same with all other Card Tools, because the quality of material, quality of workmanship, quality of design is "Card Quality" and that stands for Best in the mechanics' code.

All standard styles and sizes in stock. Special tools to order. Send for latest catalogue.





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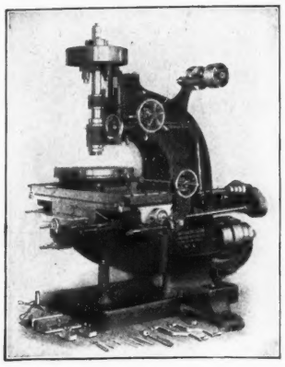
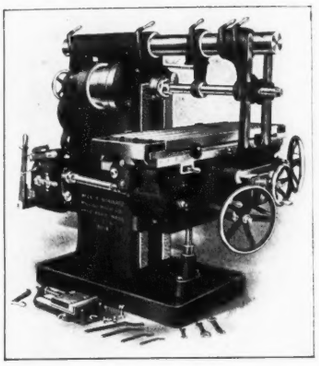


BECKER-BRAINARD
Milling Machines
AND
Milling Cutters

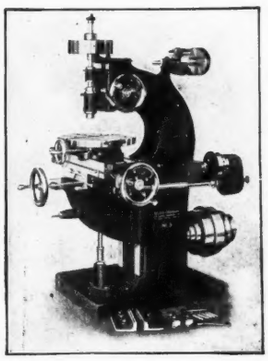


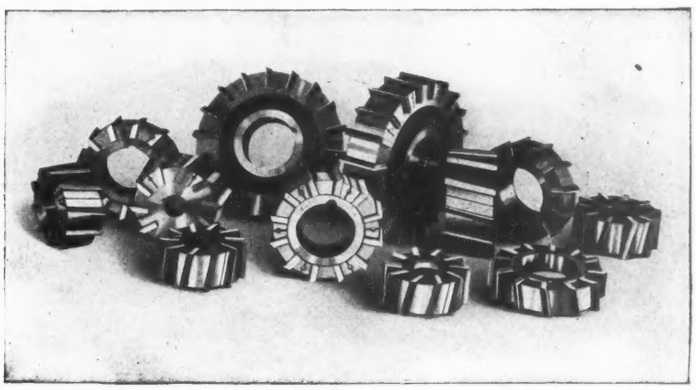
The Highest Efficiency of Production

is secured when the size and design of the machine is exactly suited to the work. We build two distinct types of Milling Machines—

The Horizontal and the Vertical

—and are therefore in a position to furnish whichever is best adapted to the work. We have reason to believe that our own experience will be of material assistance to the purchaser in selecting the machine best suited to meet his requirements. To this end we are always pleased to study specific cases, offer suggestions for improvement, determine the most desirable sizes of machines and design, and make special cutters to accomplish the desired result.





Becker-Brainard Milling Machine Company

HYDE PARK, MASS., U. S. A.

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354

Water Emery Grinder

2 x 24 INCH WHEEL

NO VALVES
NO PUMPS
Always ready for use

THIS grinder is most efficient in use, simplest in construction, and size of wheel best adapted for tool works; a wheel of less diameter or wider face gives all kinds of trouble; we know by experience and our experience saves the customer money.

Can furnish with

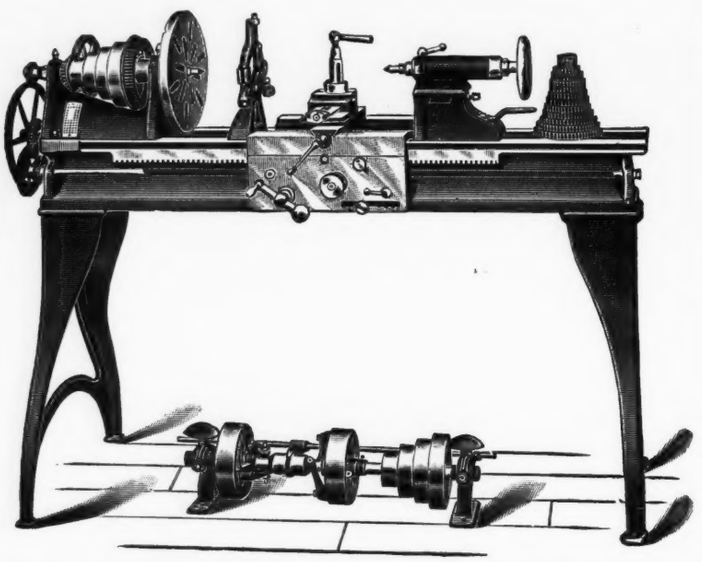
Electric or Countershaft Drive

For electric drive we use a 2-H.P. motor

SEND FOR CATALOGUE

These two tools make a pretty good start for a small machine shop. The drill is our No. 7—15-inch Swing Drill, a stiff tool for its size and well adapted for light medium work; just note the combined lever and wheel feed! The lathe is our No. 13 Lathe, swinging 13 inches over the face plate, and made in beds of 5 to 10 feet long; has automatic cross-feed and compound rest; very stiff tool carriage and changes of feed without removing a gear. We can furnish Lathe with foot power if wanted.

A good deal less than $200 will buy this Drill and the Lathe with 5-foot bed. Write for catalogue.



W. F. AND JOHN BARNES COMPANY

231 Ruby Street **Established 1872** **Rockford, Illinois**

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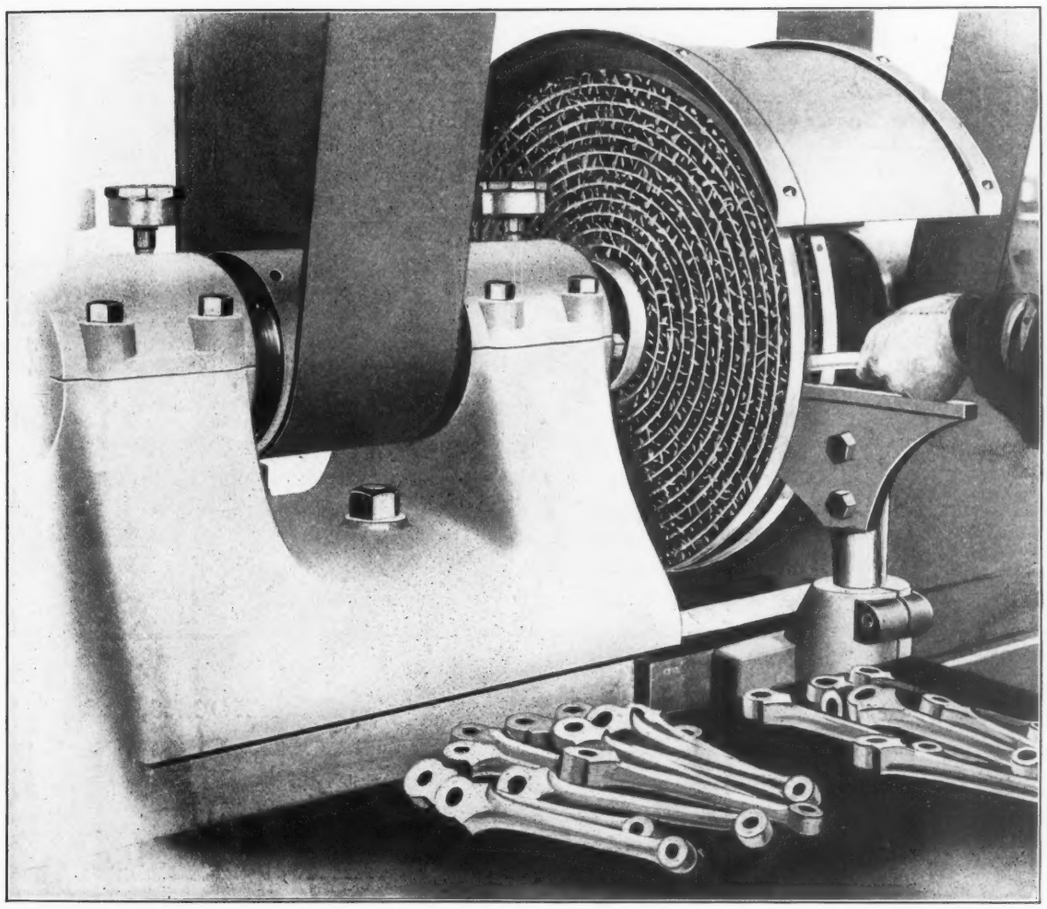
Charles H. Besly & Co

SPIRAL GROOVED DISCS SPIRAL CIRCLES

HELMET TAPS ARE THE STANDARD

ORIGINATORS OF DISC GRINDERS



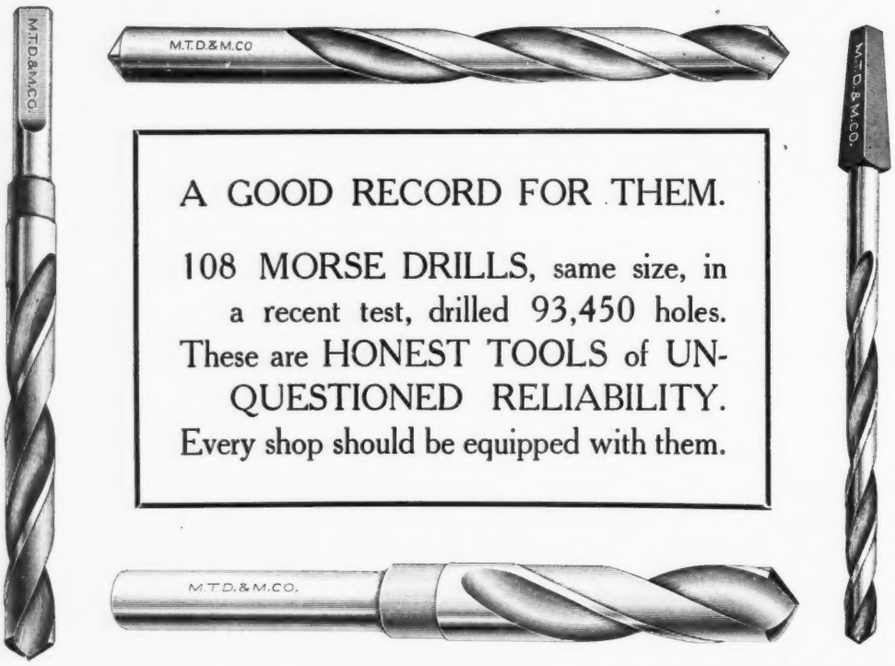
250 Bicycle Cranks an Hour

Have you any work of this kind on hand and are you interested in time saving? If so, the engraving will serve as an object lesson in economical grinding. With a No. 6 Besly Spiral Grooved Disc Grinder it is a simple matter to finish 250 cranks (500 surfaces) an hour—the forgings low carbon steel, and 1-32″ of stock removed. The accuracy of finish could not be equalled by other methods, the machine can be operated by unskilled labor and the cost of Spiral Circles employed does not exceed 3 cents per hundred surfaces ground. We shall be glad to send you full particulars of the Besly methods, or if you will send a sample of work we will grind and return it free of charge, with full data as to time, size of machine and composition of spiral circles used.

Charles H. Besly & Company

15-17-19-21 South Clinton St., Chicago, Ill., U. S. A.

"MORSE" DRILLS



A GOOD RECORD FOR THEM.

108 MORSE DRILLS, same size, in a recent test, drilled 93,450 holes. These are HONEST TOOLS of UNQUESTIONED RELIABILITY. Every shop should be equipped with them.

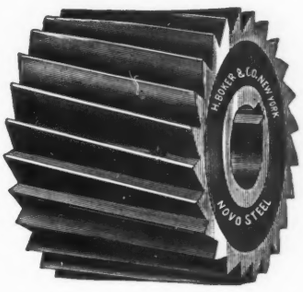
Arbors, Chucks, Counterbores, Countersinks, Cutters, Dies, Drills, Gauges, Machines, Mandrels, Mills, Reamers, Screw Plates, Sleeves, Sockets, Taps, Taper Pins, Wrenches.

Morse Twist Drill & Machine Co.

New Bedford, Mass., U. S. A.

"NOVO" MILLING CUTTERS ARE ON TOP

We carry a complete stock of Novo Spiral Milling Cutters, Side Milling Cutters, Nicked Tooth Milling Cutters, Novo Gear Cutters, and Novo End Mills.



Novo High Speed Milling Cutters

DOUBLE YOUR OUTPUT

We absolutely guarantee all our Novo Milling Cutters. A Novo Milling Cutter will outlast at least two dozen of the Carbon Steel Cutters. Novo Milling Cutters will mill the hardest and sandiest steel or iron castings.

Send us a trial order. Write for price list with full particulars.

All Novo Milling Cutters furnished subject to trial and approval.

HERMANN BOKER & COMPANY

SMALL TOOL DEPARTMENT

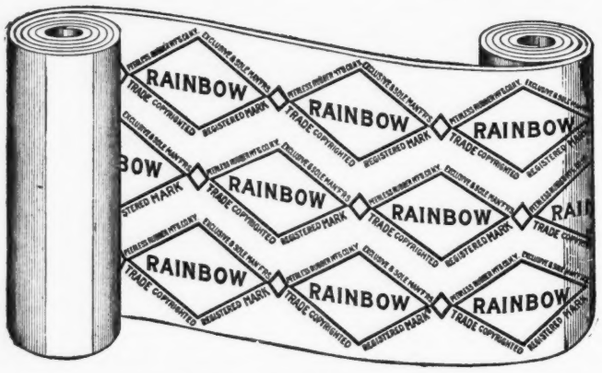
Chicago Warehouse
57 N. Desplaines Street

New York City
101-103 Duane Street

Rainbow Packing

Makes Steam, Flange and Hot Water Joints Instantly.

Thousands of Imitations No Equal. Will Hold Highest Pressure.



Don't have to use wire and cloth to hold Rainbow. Can't blow it out.

THE COLOR OF RAINBOW PACKING IS RED

Notice our Trade Mark of the Word "RAINBOW" in a diamond in Black in

Three Rows of Diamonds extending throughout the entire length of each and every roll of Rainbow Packing

WILL CARRY IN STOCK It is an undisputed fact that Rainbow Packing is the only Sheet or Flange Packing in the World that will carry in stock for months and years without hardening or cracking.

The Peerless Spiral Piston and Valve Rod Packing

Once Tried Always Used.

It will hold 400 lbs. of Steam.

Will run twelve months in high speed engines.

In Boxes 3 to 8 lbs.

Made in Three Different Shapes: Straight, Spiral and Square Spiral, in sizes from 1-4 inch to 2 inches.

WRITE FOR CATALOG

MANUFACTURED, PATENTED AND COPYRIGHTED EXCLUSIVELY BY

The Peerless Rubber Mfg. Co., 16 Warren Street, New York.

24 Woodward Ave., Detroit, Mich.
202-210 S. Water St., Chicago, Ill.
18 S. Capitol Ave., Indianapolis, Ind.
111-121 W. Main St., Louisville, Ky.
1218 Farnam St., Omaha, Neb.
1323 E. Main St., Richmond, Va.
220 S. Fifth St., Philadelphia, Pa.
177 Elm St., Dallas, Texas.

Cor. Common and Tchoupitoulas Sts., New Orleans, La.
17-23 Beale St. and 12-24 Main St., San Francisco, Cal.
Railroad Way and Occidental Ave., Seattle, Wash.
228 Front St., Memphis, Tenn.
1213 Locust St., St. Louis, Mo.
1621-1639 17th St., Denver, Col.
1221-1223 Union Ave., Kansas City, Mo.
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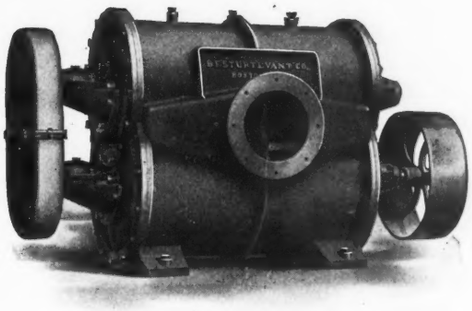
212-214 S. Clinton St., Syracuse, N. Y.
634 Smithfield St., Pittsburg, Pa.
7-9 S. Broad St., Atlanta, Ga.
61 Frankfort St , Cleveland, O.
55 E. Main St., Rochester, N. Y.
110 Federal St., Boston, Mass.
43-45 Pearl St., Buffalo, N. Y.



In the Sturtevant High Pressure Blower

there is no heavy load to be transmitted by gears because the idler has no work to do. No careful and frequent adjustment of bearings necessary to keep impellers trued up. No loss of efficiency through rubbing of impellers; because they never touch.

SEND FOR BULLETIN 127.

B. F. STURTEVANT CO., Boston, Mass.

General Office and Works, Hyde Park, Mass.

NEW YORK PHILADELPHIA CHICAGO CINCINNATI LONDON

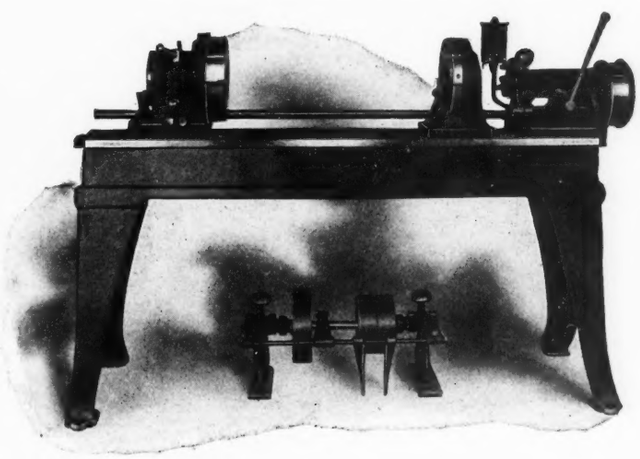
Designers and Builders of Heating, Ventilating, Drying and Mechanical Draft Apparatus; Fan Blowers and Exhausters. Rotary Blowers and Exhausters; Steam Engines, Electric Motors and Generating Sets; Pneumatic Separators, Fuel Economizers, Forges, Exhaust Heads, Steam Traps, etc.

606

THE WHITON

Revolving Centering Machine

For Accurately Centering Finished Shafts



The cut shows new REVOLVING CENTERING MACHINE—a large size of the well known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

Circular and prices sent upon application.

The D. E. Whiton Machine Company,

New London, Connecticut

A Big Lathe for what?

You haven't work for it all the time.

Why, then, should you pay **$1,000 more** for an ordinary big Lathe, lacking the facilities **McCabe's "2-in-1" DOUBLE-SPINDLE** has for doing your small work?

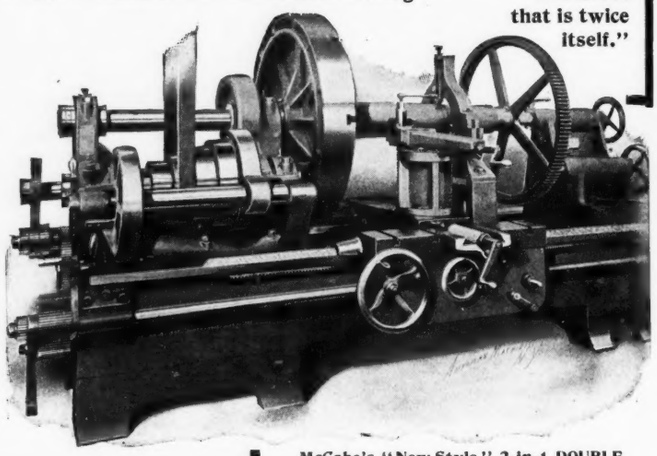
A big Lathe would only do your big work.

The **McCabe "2-in-1" DOUBLE-SPINDLE** would do it all.

Your 48-inch Lathe changed in three minutes to a 26-inch Swing—and the 26-inch Swing is the **"second something"** a shop like yours requires.

You can be sure about it, for most all the shops in your line have **McCabe's "2-in-1" DOUBLE-SPINDLE** now.

"The Lathe that is twice itself."



McCabe's "New Style" 2-in-1 DOUBLE SPINDLE LATHE 26-48-in. swing.

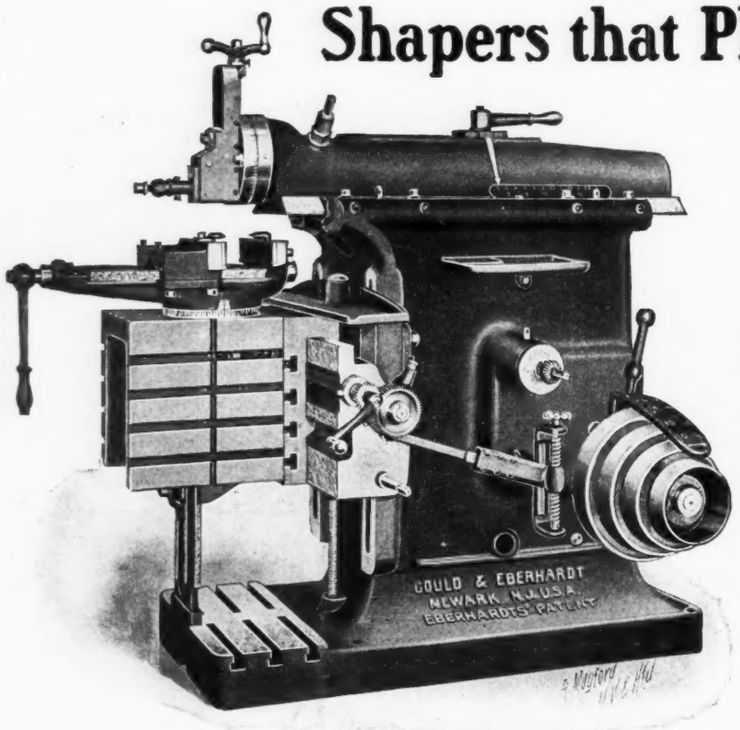
J. J. McCABE

"The Double-Spindle Lathe Man"

14 Dey Street, NEW YORK CITY

FOREIGN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester and Glasgow. R. A Hervey, Sydney, N. S. W. Sole Agents for Australasia. F. W. Horne, Yokohama, Japan.

Shapers that Plane to the Line



One advantage an Eberhardt Shaper has over the planer is that the improved crank motion insures accuracy and permits planing to the line. A shaper is also much quicker in operation, takes up far less room in the shop, and work can be more easily adjusted.

Eberhardts' Patent "D. T. Q." Stroke Crank Shapers

are exceptionally accurate machines, very powerful, adapted to obtain the best results from high speed steels, smooth running, rigid even under the heaviest cuts and have every improvement tending to save time and labor, and to increase output.

Sizes: 14, 16, 20, 24 and 34 in.

GOULD & EBERHARDT, NEWARK, N. J., U. S. A.

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Milan, Brussels, Liege, Bilbao and Paris. C. W. Burton, Griffiths & Co., London, England. F. W. Horne, Yokohama. Adolfo B. Horn, Havana, Cuba.

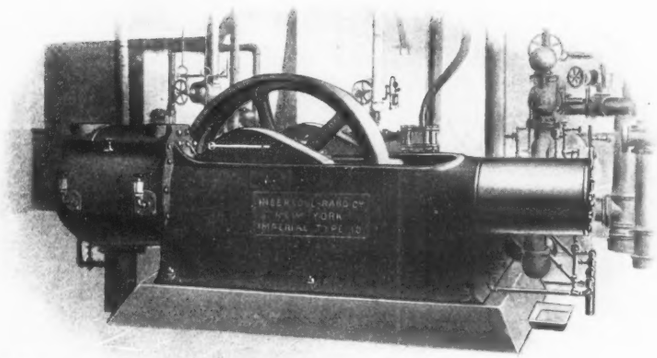
"IMPERIAL" TYPE TEN
AIR COMPRESSORS

A powerful, compact, self-contained machine of high efficiency with Corliss Intake Valves, Cushion Discharge Valves and automatic bath lubrication and with a greater capacity per unit floor space than any other type.

OIL ECONOMY

The enclosed self-oiling features of the "Imperial" result in an oil economy unequaled by any other type. A RECENT RECORD SHOWS WHERE 12-INCH STROKE "IMPERIAL" RAN FOR EIGHT MONTHS, 18 HOURS PER DAY, WITH A TOTAL CONSUMPTION OF TEN GALLONS OF OIL (MACHINE AND CYLINDER) OF WHICH SIX GALLONS WERE RECLAIMED AND FILTERED FOR FURTHER USE. This is but one of the dividend earning qualities of Ingersoll-Rand product.

Other exclusive features are described in Catalogue X-35.



2966

"Imperial" Type Ten Air Compressor in the Shops of the Illinois Central R.R. at Memphis, Tenn.

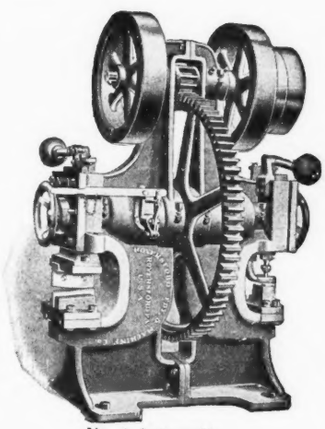
PNEUMATIC TOOLS **PNEUMATIC HOISTS**

INGERSOLL-RAND CO.

11 BROADWAY
NEW YORK

Chicago, Cleveland, San Francisco, Montreal, London, Philadelphia, Houghton, Mich., Birmingham, Halifax, N. S., Johannesburg, Butte, Toronto, Berlin, Kenora, Ont., Melbourne, Salt Lake, Rossland, B.C., Kalgoorlie, St. Louis, Pittsburg, Los Angeles, Vancouver, Valpariso, El Paso, Boston, Denver, Mexico, Paris

K 35



No. 1 Automatic

Are you interested in the Best

PUNCH AND SHEAR?

Then ask us about the

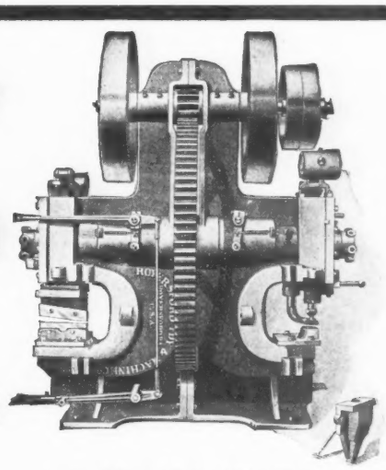
ROYERSFORD

BUILT FOR SERVICE.

VARIOUS SIZES. REQUIRES LITTLE FLOOR SPACE.

ROYERSFORD FOUNDRY AND MACHINE COMPANY,

ROYERSFORD, PA.



No. 3 Heavy Duty, 12-in. Throats

The King Machine Tool Company.

CINCINNATI, OHIO, U. S. A.

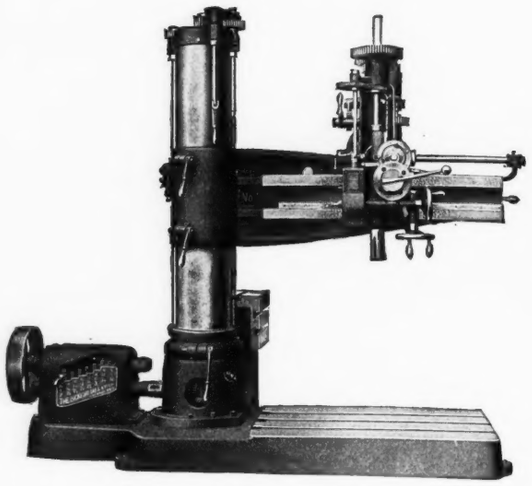
VERTICAL TURRET BORING AND TURNING MACHINES

THE TRIPLE GEARS

The New Bickford Radial
is equipped with triple gears mounted directly on the head between the spindle and tapping attachment.

One conveniently located lever operates this mechanism and gives instantly, while the machine is running, three positive changes of speed without the use of a single friction clutch.

This is another reason why BICKFORD RADIALS are cutting drilling costs wherever installed.



Improved Plain Radial.

Wouldn't you like to see our Radial catalog.

The Bickford Drill & Tool Co.

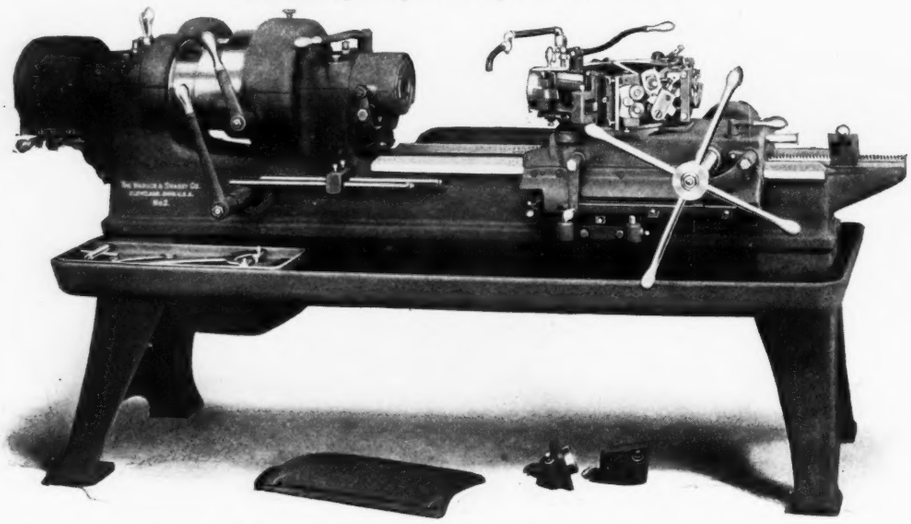
CINCINNATI, OHIO, U. S. A.

FOREIGN AGENTS—Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg, New York. Alfred H. Schutte, Cologne, Brussels' Liege, Paris, Milan, Bilbao, New York. Charles Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow· Andrews & George, Yokohama, Japan. H. W. Petrie, Toronto, Canada. Williams & Wilson, Montreal, Canada.

WARNER & SWASEY TURRET LATHES

FOR EVERY REQUIREMENT—BAR OR CHUCK WORK

Particulars upon request—or representative will call.



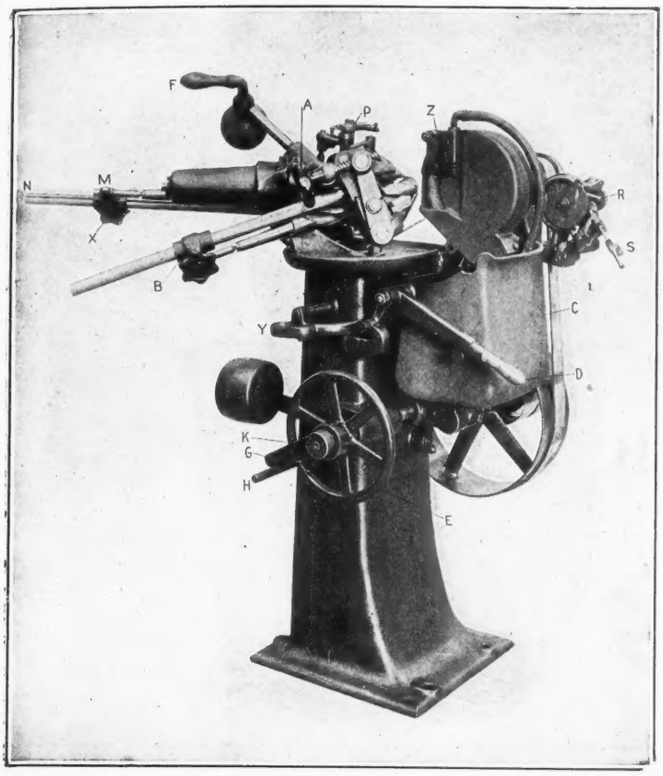
No. 2 Hollow Hexagon Turret Lathe—2¼ x 24″ Capacity

THE WARNER & SWASEY CO., CLEVELAND, OHIO U. S. A.

NEW YORK OFFICE, SINGER BUILDING, 149 BROADWAY.

FOREIGN AGENTS—Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle and Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg and Stockholm. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Turin, Barcelona and Bilboa. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal.

William Sellers & Co., Incorp. Philadelphia, Pa.



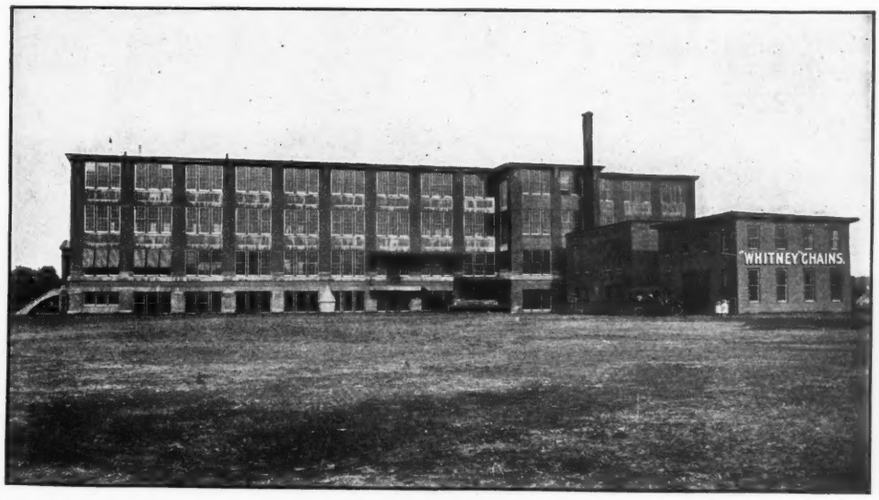
LABOR SAVING MACHINE TOOLS

Our Patent Improved Drill Grinding Machine with Pointing Attachment, shown in cut, is capable for all sizes of drills from 1/16 to 3" diameter inclusive.

Drills ground and pointed by it, last longer and do much more work before regrinding is necessary, require less power of feed and cut faster, than when ground in any other way.

The machine is extremely simple, and does not require a mechanic to handle it as nothing is left to the judgment of the operator.

SHALL WE SEND YOU A CATALOGUE?

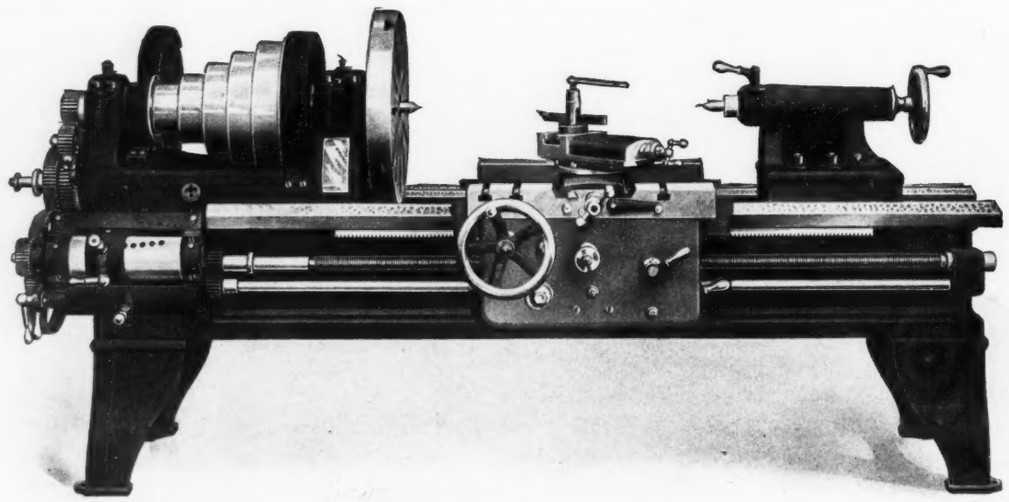


New Fireproof Factory, New Machinery and Improved Methods

HEADQUARTERS FOR

HIGH GRADE DRIVING CHAINS, KEYS AND CUTTERS FOR THE WOODRUFF PATENT SYSTEM OF KEYING, HAND MILLING MACHINES

The Whitney Mfg. Company, - - - Hartford, Conn.



LeBlond Quick Change Lathe

1906 design with "simplicity" for the watchword, backed by nineteen years experience in Lathe building. This Lathe has 18 spindle speeds, double friction back gears, head stock has largest possible cone diameters. Carriage has extra wide slide, and heavy compound rest and is furnished with chasing dial. Apron is box section; quick change box for feeds and threads; no splined shafts or key-wayed gears sliding or running on the shafts; impossible to mesh gears on the corners. This Lathe is made with an independent feed rod, the screw is not splined. *Further details in Catalog.*

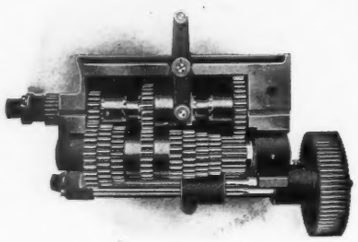
The R. K. LeBlond Machine Tool Company, 4605 Eastern Ave. CINCINNATI, OHIO

AGENTS: Germany, De Fries & Cie., Akt. Ges., Dusseldorf, Berlin, Stuttgart. Italy, De Fries e. C., Corso Prinzipe Umberto, Angolo Via Moscova, Milano. France, De Fries & Cie 19 rue de Rocroy, Paris. Belgium, De Fries & Cie, 36 rue Fosse aux Loups, Brussels. Spain, De Fries y Cia., 660 Calle de las Cortes, Barcelona.

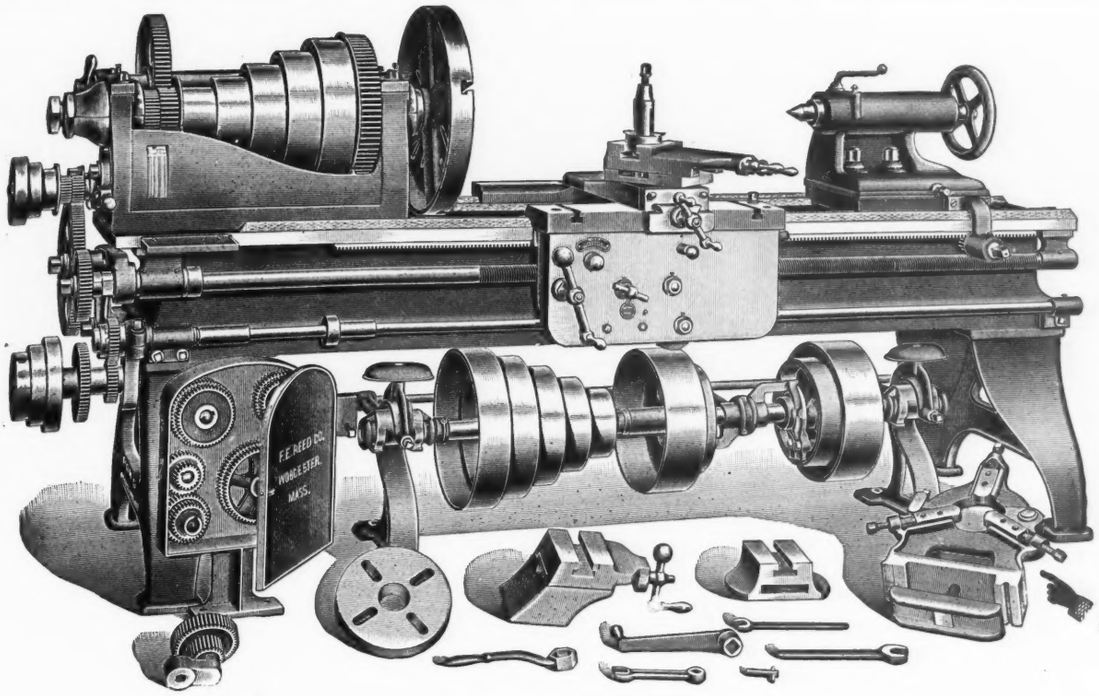
The Flather Quick Change Gear Lathe

Latest and Best.
Strong and Simple.
Greatest number of
Threads and Feeds.
Least number of Gears.

Send for descriptive circular.



Flather & Company, Incorporated, Nashua, N. H.



20" Lathe.

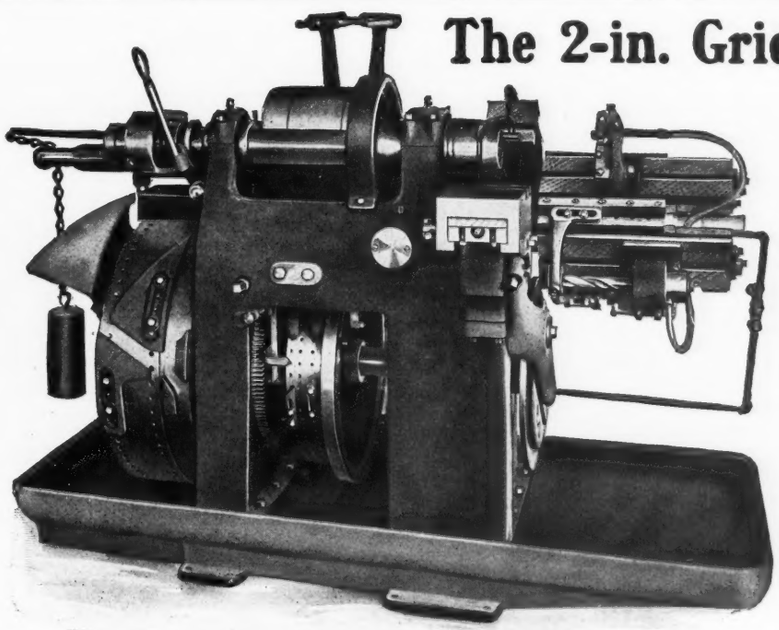
We make { 10" 12" 14" 16" 18" 20" 22" 24" 27" 30" } **Engine Lathes.**

F. E. Reed Company,

Worcester, Massachusetts,

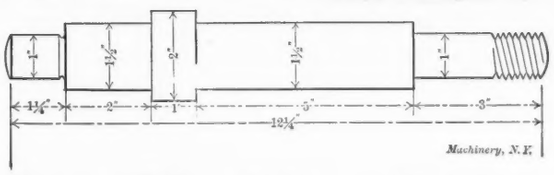
U. S. A.

Also numerous other kinds of lathes. Our specialty is REED Lathes.



The 2-in. Gridley Automatic Turret Lathe

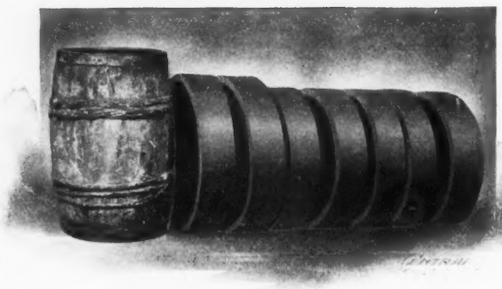
Does not require an expensive outfit of tools, and it does work twice the length of any other Automatics.



Windsor Machine Company, Windsor, Vt.

Manning, Maxwell & Moore, Inc., Sales Agents, New York, Boston, Syracuse, Pittsburgh, Philadelphia, Cleveland, St. Louis, Milwaukee, Chicago and Birmingham.

ONLY THE BEST



ONLY THE BEST

In the wake of Time,
We have stood the test;
We make the Most,
Likewise the Best.

Seamless Steel Rims, Rings, Bands and Flanges

Our products have been **accepted** by the **largest** and **most critical manufacturers** and **users** in the country, and we can make them appeal to you.

Send us your specifications for future deliveries and we will gladly quote you prices consistent with the quality of material you will demand.

WE WELD BY ELECTRICITY

Our equipment is unequaled for **welding special, irregular** and **unusual-shaped parts** for all kinds of **mechanical purposes.**

We make **a one-piece construction, impossible** by **any other method,** and hold the parts in true alignment.

If you are not familiar with our method of welding, we would like to demonstrate our ability.

**"Our weld once cold
Is sure to hold."**

YOUR INQUIRIES WILL HAVE PROMPT ATTENTION.

The Standard Welding Company

CLEVELAND

Western Representatives
McCLERNAN & ORR
1064 Monadnock Block
CHICAGO

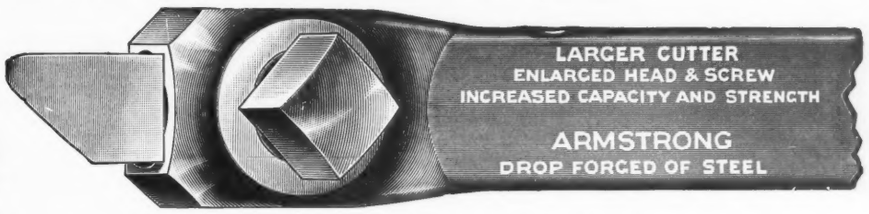
Representative
L. D. ROCKWELL
United States Express Bldg.
2 Rector St., - NEW YORK

ARMSTRONG TOOL HOLDERS

will do more work and cause less trouble than any other tools you can put on your lathes and planers. Experience counts in making tool holders just as it does in any other line, yours for instance. It's easy for us to make better tool holders than anybody else; that's been our specialty for years, and it don't cost us (or you) one cent extra. **We make a complete line. A Tool Holder for every operation on the lathe and planer.**

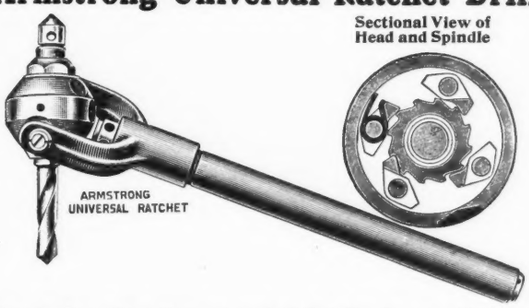
Cutter is Extra Large and is supported directly under strain of cut.

Our Patented Relieved Seat prevents chattering and breaking of cutter.



Patented February 28, 1893, and patent pending.

Armstrong Universal Ratchet Drill

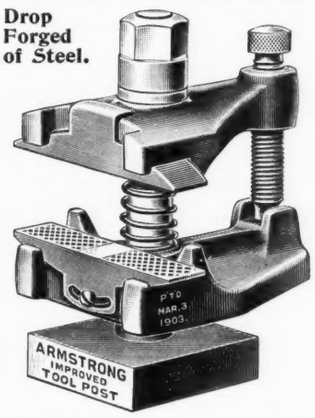


Two inches of motion, at end of handle, in *any direction* will drive the drill. No lost motion—cuts faster than common ratchet. Write for special circular.

A Few of these Ratchets

in your erecting or repair department will repay their cost many times in the course of a year. They have a special field of their own in which neither air or electric drills nor the common ratchet can compete.

Drop Forged of Steel.



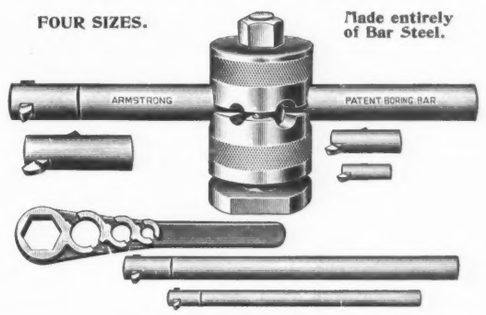
The Armstrong Improved Tool Post

FOUR SIZES

OUR Improved Tool Post combines in itself the strength and holding power of the Strap and Stud Tool Clamp with the convenience of the "open side" and ordinary Set Screw Tool Post. Write for special circular.

3-Bar Boring Tool

FOUR SIZES. **Made entirely of Bar Steel.**



Increases production and reduces cost of tool maintenance. Cutters cannot jar loose. **High Speeds and Big Feeds** only set them tighter. Write for special circular.

Do you want our new catalog? It's A Tool Holder Encyclopedia.

Armstrong Bros. Tool Co., "The Tool Holder People" 113 N. Francisco Avenue, CHICAGO, U. S. A.

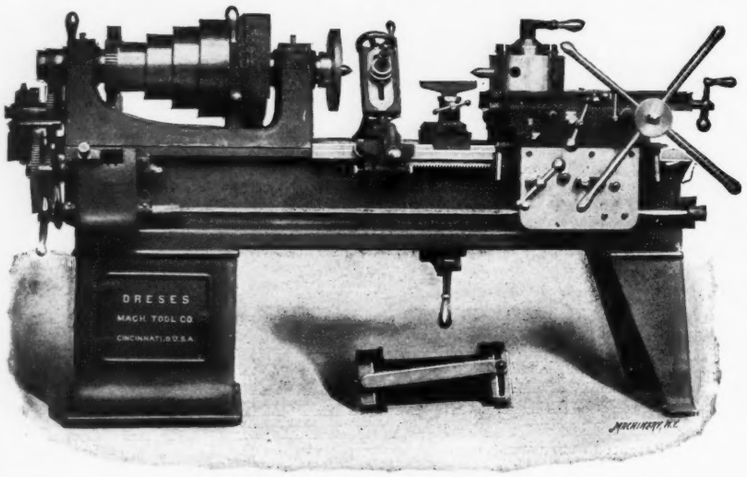
Imitations are Unsatisfactory ::: Infringements are Unlawful.

TURRET AND BRASS LATHES

IN THIS LINE WE CALL SPECIAL ATTENTION TO OUR NEW

20-inch Full Universal Monitor Lathe

OF WHICH NOTICE THE FOLLOWING FEATURES:

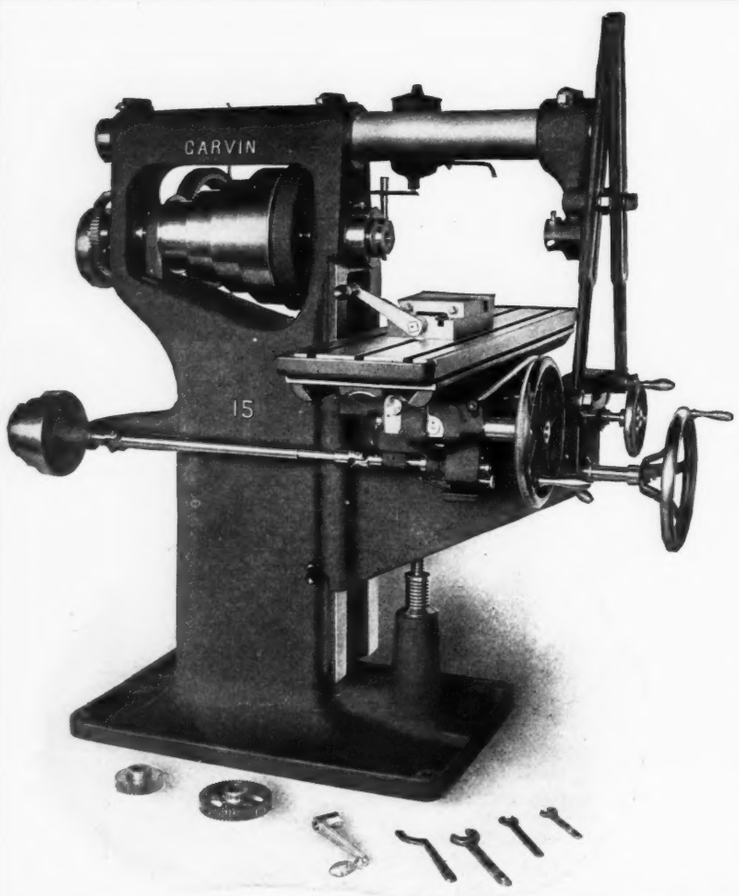


20-inch Full Universal Monitor Lathe.

- Specially adapted for *general* brass and similar work.
- Geared feed so proportioned to cut 8, 11½, 14 and 18 pipe threads and others without change.
- Friction back geared head of the most approved and simple design.
- Eight changes of geared feed obtained instantly.
- Detachable pilot wheel to turret slides.
- Screw feed to turret slide for fine adjustment.
- Removable taper attachment.
- Straight and taper in and outside turning and screw cutting by means of turret and power feed.
- Semi-automatic turret.
- Chasing bar cuts right and left hand threads without changing.
- Three point principle support of bed to assure alignment.

DRESES MACHINE TOOL CO., Cincinnati, Ohio, U. S. A.

REPRESENTATIVES—The Fairbanks Co., New York, Philadelphia and Montreal. Carey Mchy. and Supply Co., Baltimore. O. L. Packard Mchy. Co., Chicago and Milwaukee. The Motch & Merryweather Mchy. Co., Cleveland. Wm. C. Johnson & Sons Mchy. Co., St. Louis. The Strong, Carlisle & Hammond Co., Detroit. Vandyke Churchill Co., Pittsburg. Pacific Tool and Supply Co., San Francisco. Selig, Sonnenthal & Co., London. E. Sonnenthal, Jr., Berlin and Koln. Wilh. Sonesson & Co., Malmo, Sweden. Stussi & Zweifel, Milan, Italy. Alfred Herbert, Ltd., Paris, France. White, Child & Beney, Vienna, Austria.



THE JOBBING MILLER

GARVIN

No. 15 Plain Milling Machine

Suitable for every kind of plain milling. Our catalog describes its many advantages including our SOLID TOP EXTENDED (PATENTED) KNEE, write for it. Quotations made now include August deliveries.

The Garvin Machine Co.

Spring and Varick Sts., N. Y. City.

AGENTS: *Chicago, Cleveland and Detroit*, Manning, Maxwell & Moore, Inc. *Providence*, Thornton Machinery Co. *Boston*, Thos. Crowther & Co., 170 Oliver St. *Philadelphia*, E. L. Fraser, 50 North 6th St. *Charlotte, N. C.*, Textile Mill Supply Co. *San Francisco*, J. L. Hicks, 967 Howard St. *Los Angeles*, L. Booth & Son, 262 Los Angeles St. *Mexico*, Manning, Maxwell & Moore, Inc., Apartado, 416. *London*, C. W. Burton, Griffiths & Co., Ludgate Sq. *Stockholm*, Hugo Tilquist, Maskin Agentur. *Liege*, A. Engelmann & Co. *Paris*, L. Strasburger & Cie, 73 Rue de Maubeuge. *Berlin*, Heinrich Drever, Kaiser Wilhelm Strasse, 47. *Dresden*, (A-3), Hermann Haelbig. *Milan*, Teodoro Koelliker.

Thirty-two Changes of Feed

Without Shifting a Belt or a Gear. Does this feature of the

"OWEN"

No. 2-A Universal Miller

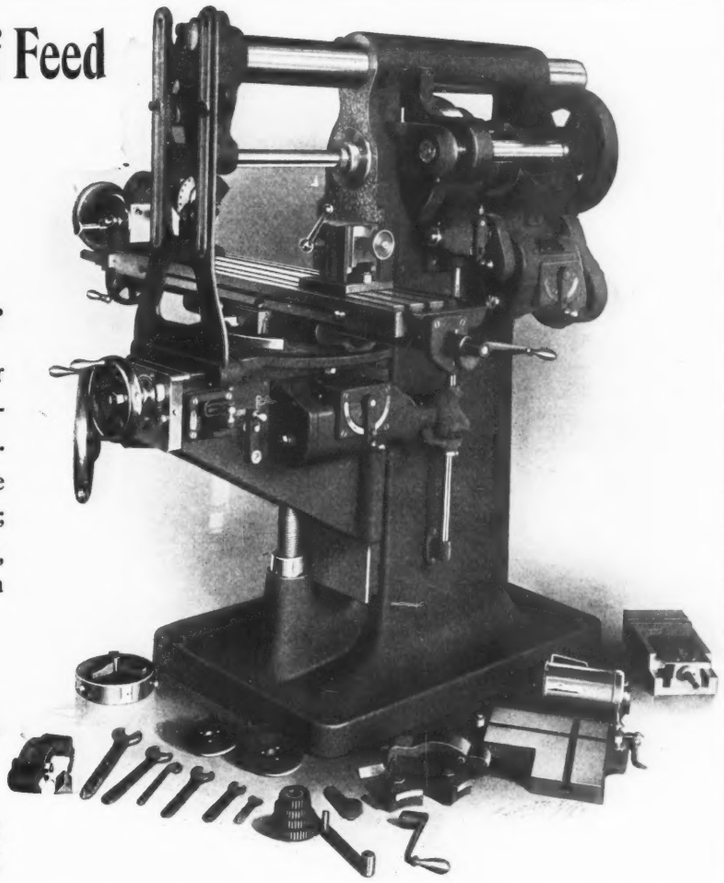
Strike you favorably? There are other points that will make an equally good impression if you will inquire into them. "OWEN" Milling Machines are the modern millers; built for high speed work; accurate, rigid, powerful. Gear drive, double bearing surfaces to table, column extra heavy at front spindle bearing.

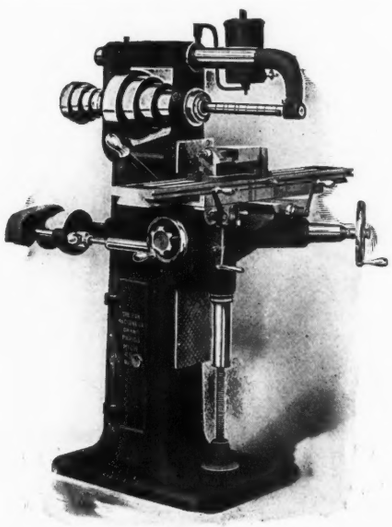
Special Circular mailed on request

THE OWEN MACHINE TOOL CO.

Springfield, Ohio, U. S. A.

FOREIGN AGENTS—Alfred Herbert, Ltd., Coventry, England. DeFries & Co., Akt. Ges., Dusseldorf, Berlin and Stuttgart, Germany; Milan, Italy; Barcelona, Spain. Louis Besse, Paris, France. Wilh. Sonesson & Co., Malmo, Sweden.





FOX MILLERS

We make a specialty of Milling Machines for light work which are particularly designed for such service as requires extreme accuracy to be coupled with low cost of production. For the manufacture of instruments of all kinds, sewing machines, small firearms, typewriters, talking machines, telephone and telegraph instruments and all classes of light electrical work, the machines are ideal.

Illustrated catalog free.

Fox Machine Co. 815 N. Front Street Grand Rapids, Mich.

No **Tool Room** is complete without a

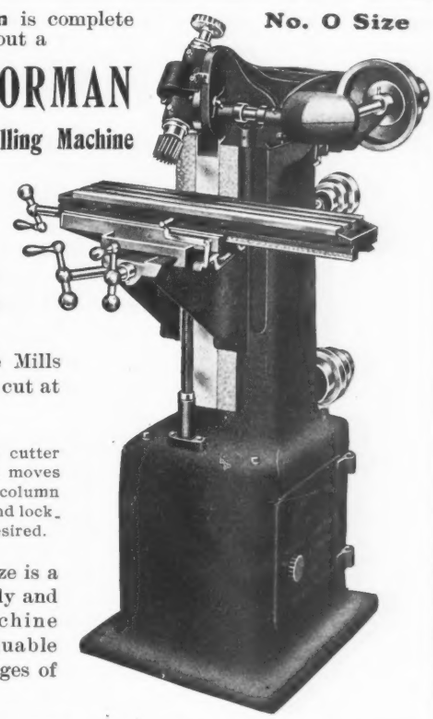
No. 0 Size

VAN NORMAN

"DUPLEX" Milling Machine

IT

saves **Time**
saves **Money**
saves **Cutters**
saves **Fixtures**



Right Angle Mills can be used to cut at all angles.

Ram on which cutter head is mounted moves in and out over column and may be set and locked at any point desired.

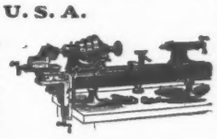
The No. 0 size is a powerful, handy and accurate machine especially valuable for quick changes of operation.

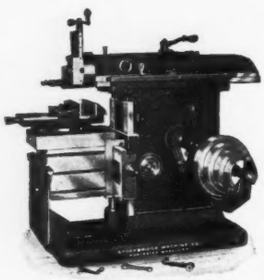
Waltham Watch Tool Company

Springfield, Mass., U. S. A.

No. 5 Bench Lathe

The Van Norman No. 5 Bench Lathe split chucks will also fit the Van Norman "Duplex" Millers—a good combination.





"It's a Worker"

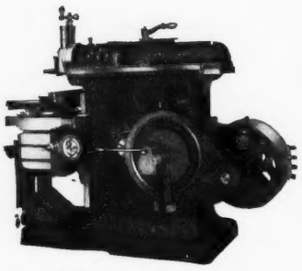
BELT OR MOTOR

drive it makes no difference—if it's a

Stockbridge Patent (Two-Piece) Crank Shaper

it's the best money can buy.

Built by People Who Care



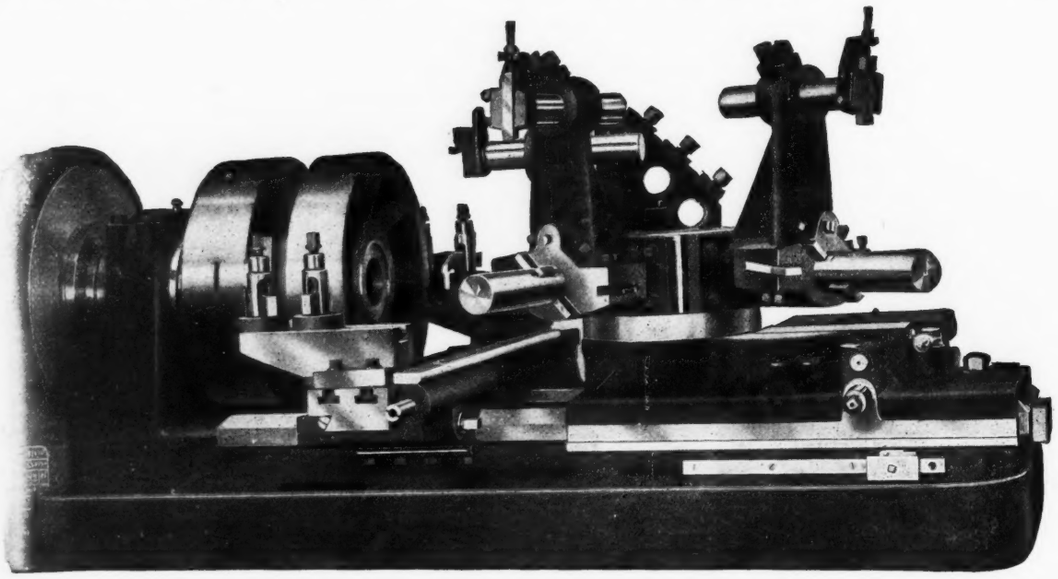
"It's a Worker"

STOCKBRIDGE MACHINE CO., Worcester, Mass.

Automobile Gas Engine Fly Wheel

Automatically Machined as shown on

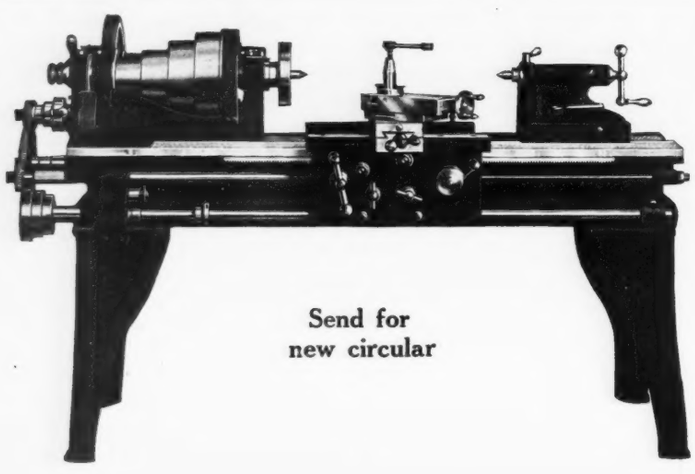
Potter & Johnston Manufacturing Automatics



Piece finished complete at one holding. One attendant operating four machines. Machines adapted for handling other equally interesting subjects. Estimates of production on the MANUFACTURING AUTOMATICS cheerfully furnished.

POTTER & JOHNSTON MACHINE COMPANY, Pawtucket, R. I., U. S. A.

Paris Office, 78 Avenue de la Grand Armee, J. Ryan, Manager. New York Office, 114 Liberty St., Walter H. Foster, Manager. Cleveland Office, 309 Schofield Building, W. E. Flanders, Manager. Chicago Office, 933 Monadnock Building. Foreign Agents: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, England and Glasgow, Scotland. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, Vienna, St. Petersburg.



Send for new circular

Robbins New Model Standard Engine Lathes

This cut represents our 15" lathe with compound rest.

These machines have all the advantages for economic production, without expensive complicated attachments.

The head and tail spindles are cast crucible steel.

The head is powerfully back-geared, with four step cone for extra wide belt, and speeds arranged in regular gradation. The rest has extra long bearings on the ways and is securely gibbed to the bed.

The workmanship is of the best.

The Robbins Machine Company

149 Lagrange St., Worcester, Mass.

Special Attachments

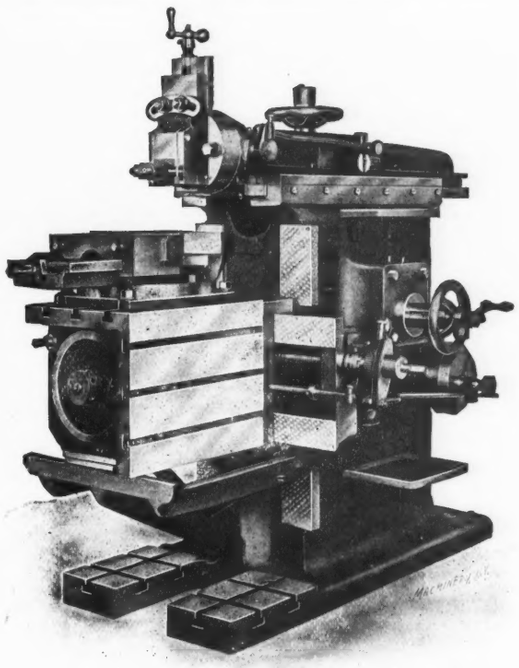
Swivel Box Table

Tilting Box Table

Circular Planing Attachment

Convex Planing Attachment

Oil-Pan and Pump



Special Attachments

Concave Planing Attachment

Automatic Stop for Saddle

Rack-Cutting Attachment

Index Centers

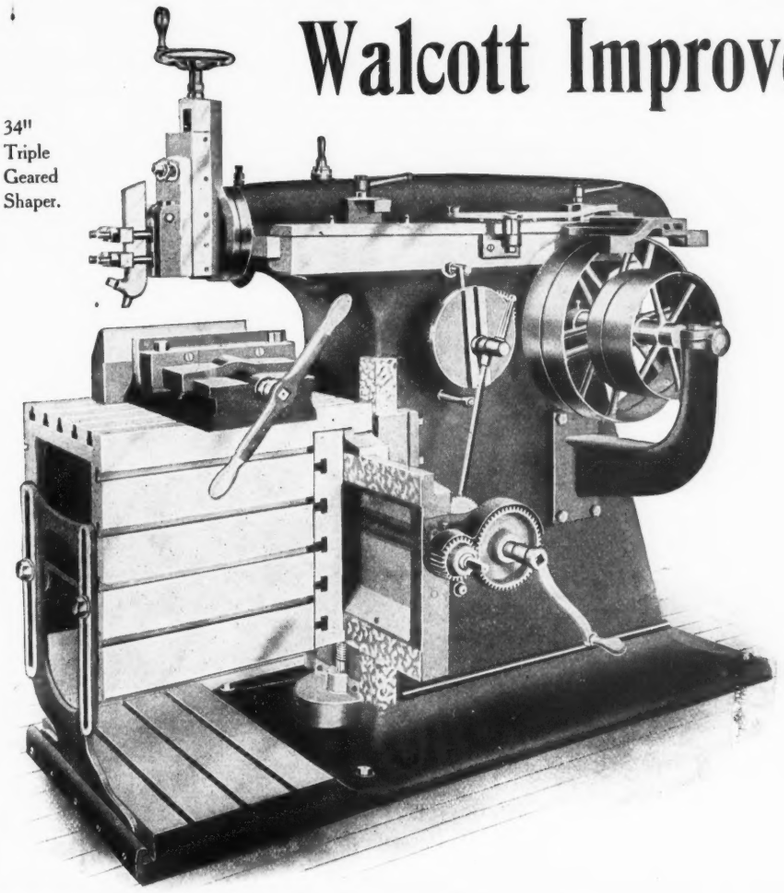
Special Tool Room Shaper with Attachments

Printed matter on request

The Mark Flather Planer Co., Nashua, N. H., U.S.A.

Walcott Improved Shapers

34" Triple Geared Shaper.



Our new line machines are very powerful, compactly built, convenient and rapid producers.

Look this **34-inch Triple Geared Shaper** over—it has a heavier ram than the older model, new table support and T-slot base, quick stroke and all facilities for handling modern work with speed and accuracy.

Full line of sizes.
Also Rack Cutting Machines.

Walcott & Wood Machine Tool Co.

Jackson, Mich.

Succeeding GEORGE D. WALCOTT & SON.

Agents—Frevert Machinery Co., New York. Chandler & Farquhar Co., Boston. Chas. G Smith Co., Pittsburg. Strong, Carlisle & Hammond Co., Cleveland. H. A. Stocker Machinery Co., Chicago.
Foreign Agents—Fenwick Freres & Co., Paris. Buck & Hickman, Ltd., London. Heinrich Dreyer, Berlin, Germany.

This is our

Power Forcing Press

with Motor Drive

can be set up on your *erecting floor* where you put your work together and SAVE ITS COST in a short time BECAUSE

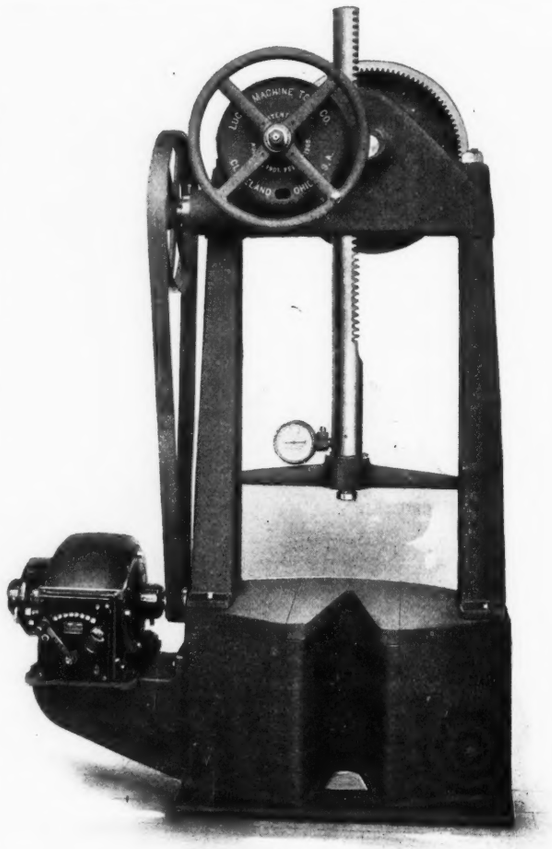
LABOR is Expensive. POWER is Cheap.

Pressure *instantly available* and under absolute control.

Quick Vertical Adjustment to Ram.

NO TIME LOST adjusting press for high or low jobs. If you haven't seen or used it, you will be surprised to learn how much you have missed.

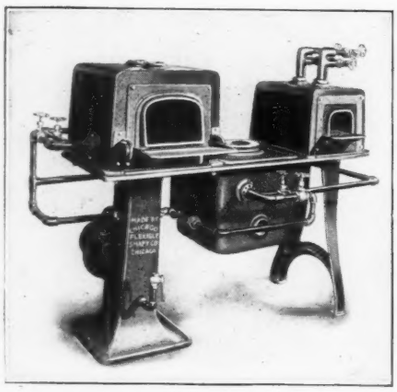
Two Standard Sizes, 15 and 30 Tons Capacity.



Lucas Machine Tool Co.

CLEVELAND, OHIO, U. S. A.

Foreign Agents: C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg.



Stewart Improved Combination Furnace

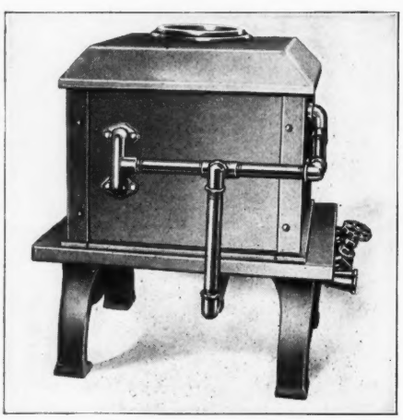
Have you steel tools to heat or harden? Small machine parts, high grade steel to temper? Have you been worried over the work—uncertain of results?

A Stewart Gas Blast Furnace will heat steel of all kinds, do it properly, do it quickly and relieve your mind of all anxiety.

These furnaces are made in such a variety of styles and in so many sizes that they are adapted for almost every heating purpose.

Their construction permits the maintenance of a uniform temperature under all conditions because the heat is absolutely controlled. They are compact, clean, burn but a few cents worth of gas an hour, and are doubly economical because there is no spoiled work to reckon against them.

Let us explain the Stewart method. Sold with the proviso of a 30 days' trial to prove their worth.



Crucible Furnace for high speed Steels

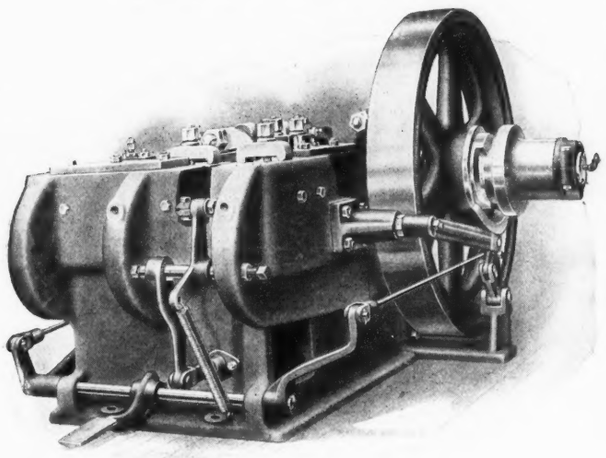
Chicago Flexible Shaft Company

149 LASALLE AVENUE, CHICAGO, ILLINOIS, U. S. A.

Foreign Agents—Niles Tool Works Co., London, England. Fenwick Freres & Co., Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

UPSETTERS

HIGHLY IMPROVED

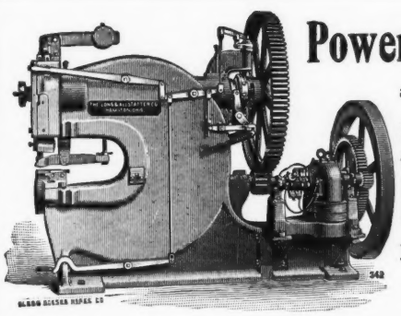


THIS MACHINE HAS SOME VALUABLE IMPROVEMENTS OVER OTHER MAKES. WE INVITE INQUIRIES.

GET OUR CATALOG

WILLIAMS, WHITE & CO.

MOLINE, ILL.



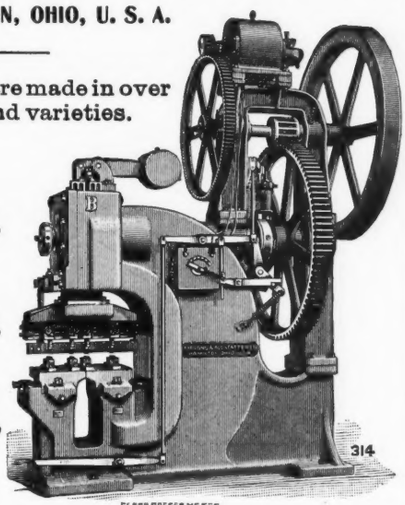
Power Punching and Shearing Machines

Belt, Steam and Electrically driven.

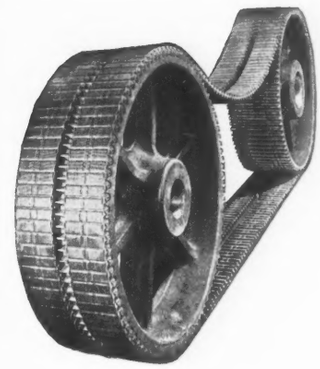
LONG & ALLSTATTER CO.

HAMILTON, OHIO, U. S. A.

Our machines are made in over 350 sizes and varieties.



SINGLE,
DOUBLE,
UPRIGHT,
HORIZONTAL,
GATE,
MULTIPLE,
FOR
Railroad Shops,
Locomotive Shops,
Bridge Works,
Etc.



The Morse

Rocker Joint High Speed Chain

The Most Efficient

The roller bearing in every joint practically eliminates friction at this point.

The Most Durable

The hardened steel rocker-joint reduces wear to a minimum.

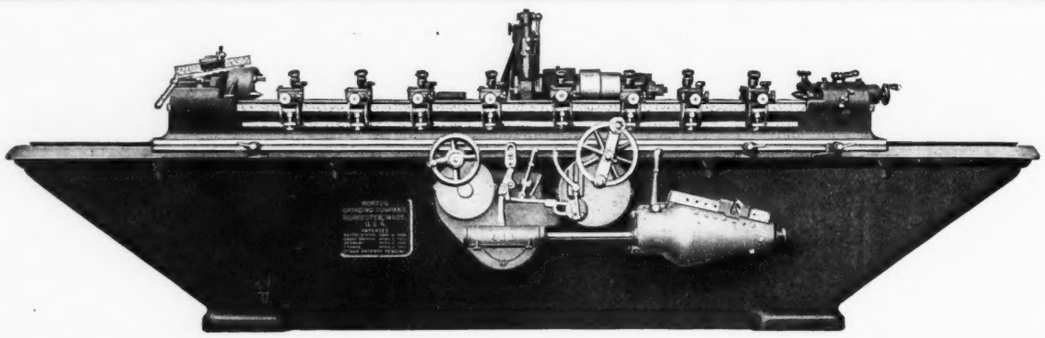
Morse chains should be carefully considered for all powers where high efficiency and a noiseless, compact and positive drive is desired.

Send for our Chain Drive Catalog No. 7.

MORSE CHAIN CO.

ITHACA, NEW YORK

Licensees for Great Britain and Europe: The Westinghouse Brake Co., Ltd., 32 York Road, Kings Cross, London, N.



If You Wished to Use a Piece of Metal

and its strength and adaptability for the purpose you had in mind were unknown to you, you'd test it, wouldn't you?

When you buy a grinder, the facts of the machine are unknown to you; yet you take the "say so" of manufacturers. Why not insist upon actual tests of your work being made? We urge you to let us take some work just as it lies upon the benches in your shop and show what a **Norton Grinder** will do for you.

Norton Grinders have a wide range of speeds, which can be changed without the least trouble and without stopping either work or wheel.

Ample provisions are made for a large water supply, and they have no pipes or channels to become clogged.

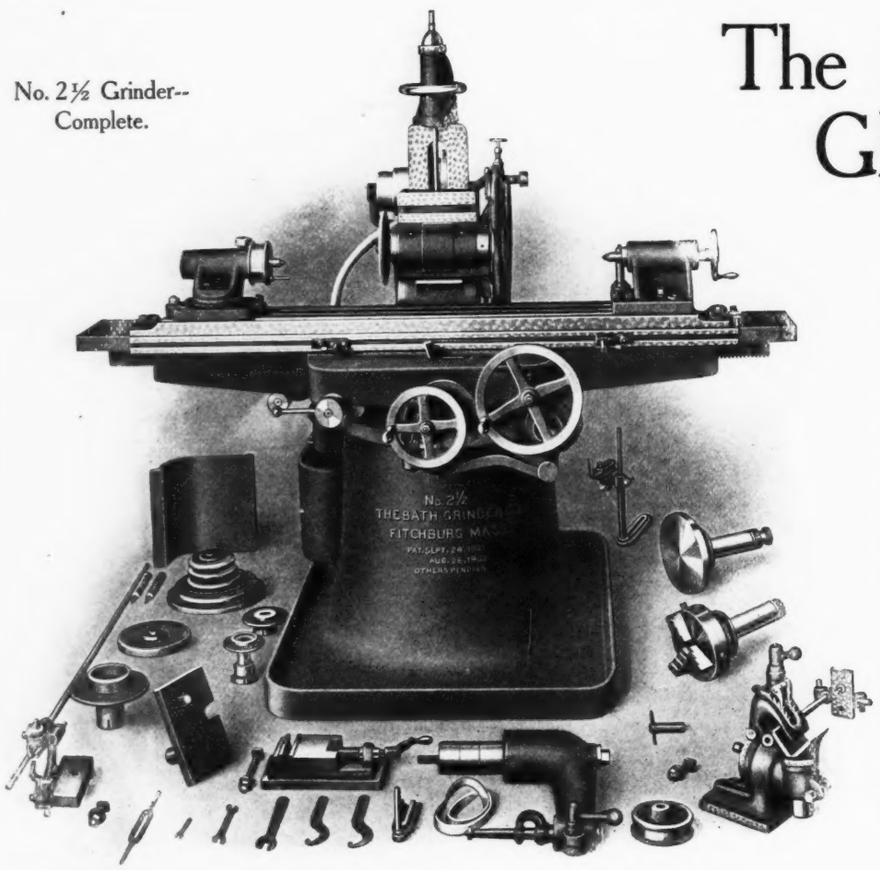
Backed by 20 years' experience. Ask for Catalog N-7, 1907.

NORTON GRINDING COMPANY, Worcester, Mass., U.S.A.

48 So. Canal Street, Chicago

Ludw. Loewe & Co., Ltd., London, Berlin, European Agents. F. W. Horne, Yokohama, Japan. 4 N.

No. 2½ Grinder--
Complete.



The BATH GRINDER

There is an end to trouble in the grinding department after you install Bath machines.

These grinders are strongly built, accurate, rapid in operation, rigid under all conditions and will handle a range of work that cannot be equalled by other methods.

Catalogue No. 6 on request.

The Bath Grinder Co.

Fitchburg, Mass.

YOUR GRINDER

Is directly responsible for the Quality and Quantity of work to be turned out economically.
YOU can help HIM by furnishing

NORTON GRINDING WHEELS

Made of

ALUNDUM

Will grind any kind of work satisfactorily if you have the right grade and grain. It is not enough to buy ONE Grinding Wheel and use that for all kinds of work —we make many grades of wheels suitable for many kinds of work. Give us the opportunity to help you in the selection. Booklet on Alundum will interest you.

NORTON COMPANY

New York
26 Cortlandt Street
Havemeyer Bldg.

Main Works: WORCESTER, MASS., U.S.A.

Chicago Store
48 So. Canal Street

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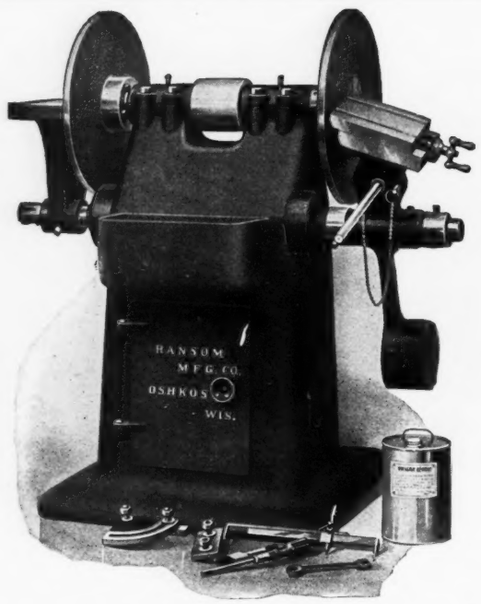


It is to your advantage to know whether or not the

Ransom Disc Grinder

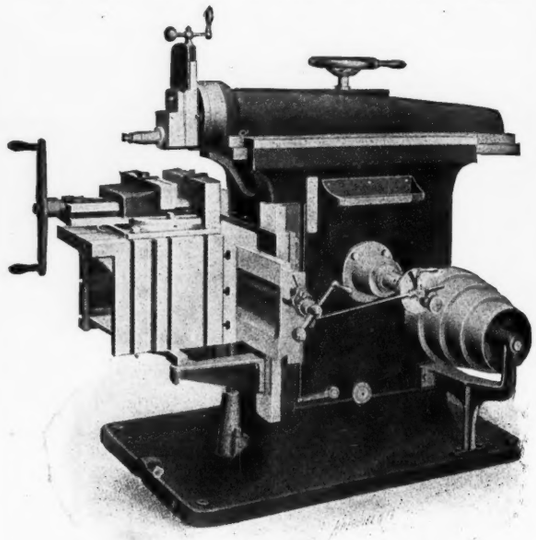
will save you money. You can easily find out by sending us samples of your work to be ground free of charge. Our style "D" Grinding Circles remove more metal and last longer than others.

Ransom Mfg. Company, Oshkosh, Wis.

European Agents: Ludw. Loewe & Co., Berlin, Germany

Kelly 26-inch. Shaper

Back Geared or Plain Just as You Prefer or Your Work Requires.

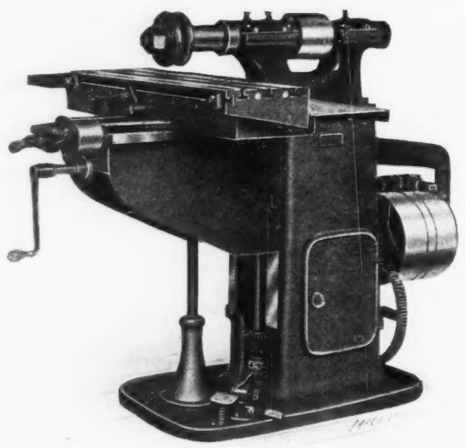


Adapted for severe service. Strong and Durable. Eight cutting speeds without stopping the machine. Equal rigidity on long or short stroke. Table support a part of the machine.

Write for Crank Shaper Catalogue.

15, 17 and 20" stroke Plain.
16, 20, 24 and 26" stroke Back Geared.

THE R. A. KELLY CO., Xenia, Ohio



Saxon Surface Grinder

For producing accurate flat surfaces at a low cost. Feeds at each end of the stroke. No lost time. Well designed and thoroughly built. Low repair cost. Has made good in the manufacturing department as well as the tool room. Adapted to either. The price—well that is just as attractive as the other features. The circular comes at your request.

SAXON MACHINE COMPANY

HOLYOKE, MASS.

DO YOU KNOW A TOOL THAT IS USED MORE THAN A TWIST DRILL?

Our CATALOG shows nearly 50 styles.

May we send it?

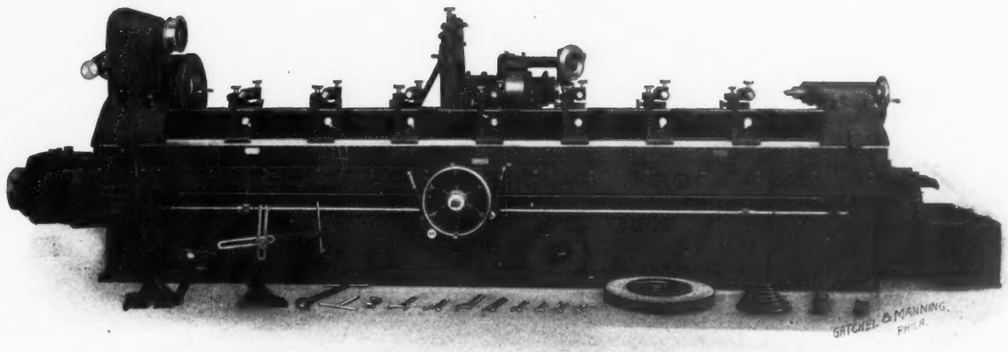
Do you know a tool that is more ABUSED than a twist drill? Ground by hand, so one lip does all the cutting, it's rammed through metal as if it were a punch. No wonder they drill holes larger than they ought to be. No wonder they break.

It's because the NEW YANKEE DRILL GRINDER grinds drills so the cutting is evenly divided between the two lips that drills thus ground do so much more work than others. They're also hard to break, for there's no undue strain on them. And as to the time it takes to grind them, this is far less than by hand, so there is a saving all around.

Wilmarth & Morman Co.

580 Canal Street, GRAND RAPIDS, MICH.

Landis Grinding Machines



No. 29 Plain Grinding Machine—20" Swing—144" between Centers

On the Landis Grinding Machines the operator is at all times enabled to note when contact takes place—this being true when grinding the largest pieces the machine will take. Consequently we point out this valuable feature especially when grinding large work. The Emery Wheel Feed Up Hand Wheel is in a convenient position. This is important.

Landis Tool Company, Waynesboro, Pa., U.S.A.

AGENTS—W. E. Flanders, 309 Schofield Bldg., Cleveland, O., and 933 Monadnock Block, Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm and St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris, Bilbao. A. R. Williams Mchy. Co., Toronto. Williams & Wilson, Montreal, Canada.

Two to One

Two ordinary keyseats can be finished on the Giant Key-seater before one piece can be fastened ready for keyseating on any other style machine. The grooved post which holds the work and forms a guide for the tool is the distinctive feature of this machine, making it possible to obtain perfectly true, straight keyways whether the hole is straight or taper, or whether the hub is faced true or left rough as it comes from the foundry. Each job is accurately set and fastened by its bore only. Another important point is the solid support of the tool so it cannot spring.

Made in Six Sizes.

Write for Key-seater Book.

MITTS & MERRILL,

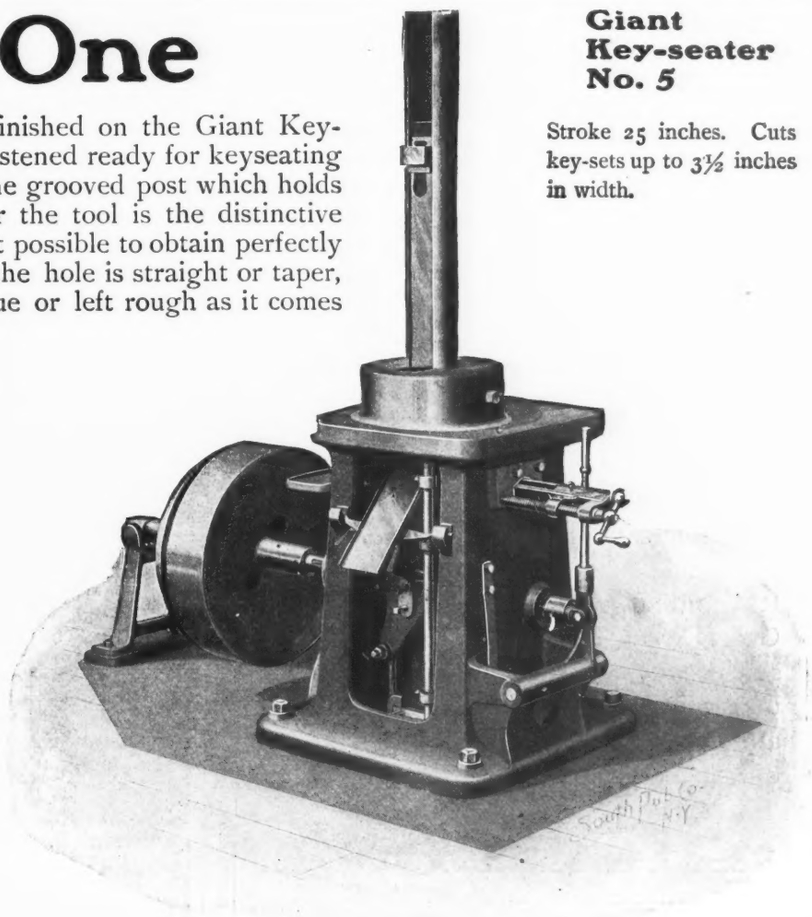
843 Water Street,

Saginaw, Mich.

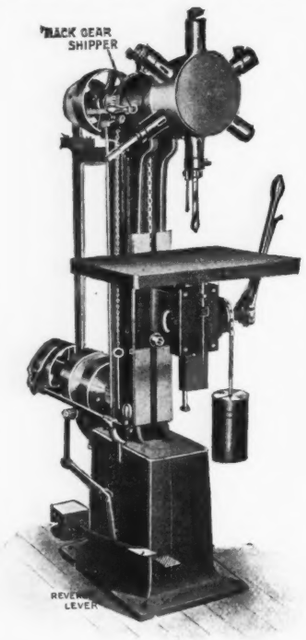
FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, Eng. Adler & Eisenschitz, Milano, Italy. Alfred H. Schutte, Barcelona, Spain. Heinrich Dreyer, Berlin, Germany and Austria. J. E. Chabert & Co., 64 Ave. de la Republique, Paris, France. F. H. Hunter & Co., Osaka, Japan. Palmer & Co., Wellington, New Zealand.

Giant Key-seater No. 5

Stroke 25 inches. Cuts key-sets up to 3½ inches in width.



Quint Improved Turret Drill No. 2.



6 to 12 spindles.

Adapted for light or medium work, where short cuts and a wide range in the sizes of holes is desired.

This machine is fitted with ratchet lever feed, back gears which can be clutched in and out while running, and reverse motion for tapping.

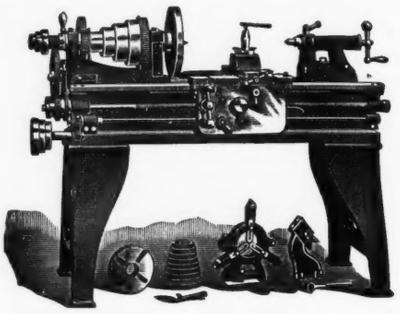
Other good features we shall be glad to explain if you are interested.

QUINT DRILLS--4 Sizes and 35 Styles.

A. E. QUINT, Hartford, Conn., U.S.A.

FOREIGN AGENTS: Ph. Bonvillain & E. Ronceray, Paris. G. Koeppen & Co., Moscow, Alfred H. Schutte, Cologne, Brussels, Liege, Milan and Bilbao. Herman Haelbig, Dresden. Andrews & George, Yokohama.

All the Latest Time and Labor Saving Improvements are Embodied in the New 15-in. Sebastian Lathe



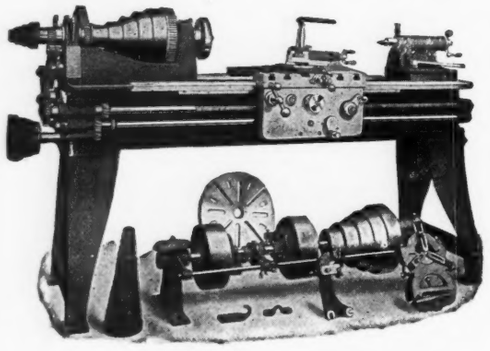
This is an essentially high grade machine adapted to meet the requirements of up-to-date manufacturing. All parts are heavy and substantial, workmanship and material unsurpassed, operation rapid and easy. Screw and rod feed as well as power cross feed. Cuts right or left hand threads. Feeds right or left.

Shall we mail a special circular?

Sebastian Lathe Company

129-131 Culvert St., Cincinnati, O.

A RAPID REDUCTION LATHE



The Von Wyck 15" Engine Lathe

is especially adapted for this class of work. It is fitted with instantaneous Change Gear Device, has a very massive headstock, preventing chatter or vibration under heavy cuts, and is equipped with all improvements for rapid and convenient operation.

CATALOGUE ON REQUEST

Von Wyck Machine Tool Co.

Cincinnati, Ohio, U. S. A.

Duplicate Drilling, Reaming, Tapping, Etc.

can be accomplished on this

New Cylinder Turret Drill

in less time, with less power and with less labor than on any similar machine.

All operations performed without changing the tools or the work.

Permanent alignment maintained.

Strain passes from turret to the frame of machine as soon as the power is applied.

Feed can be changed instantly. Turret turns either way.

An ideal tool for high speed steels.

Write for new catalogue.

National Separator and Machine Co.

CONCORD, N. H.

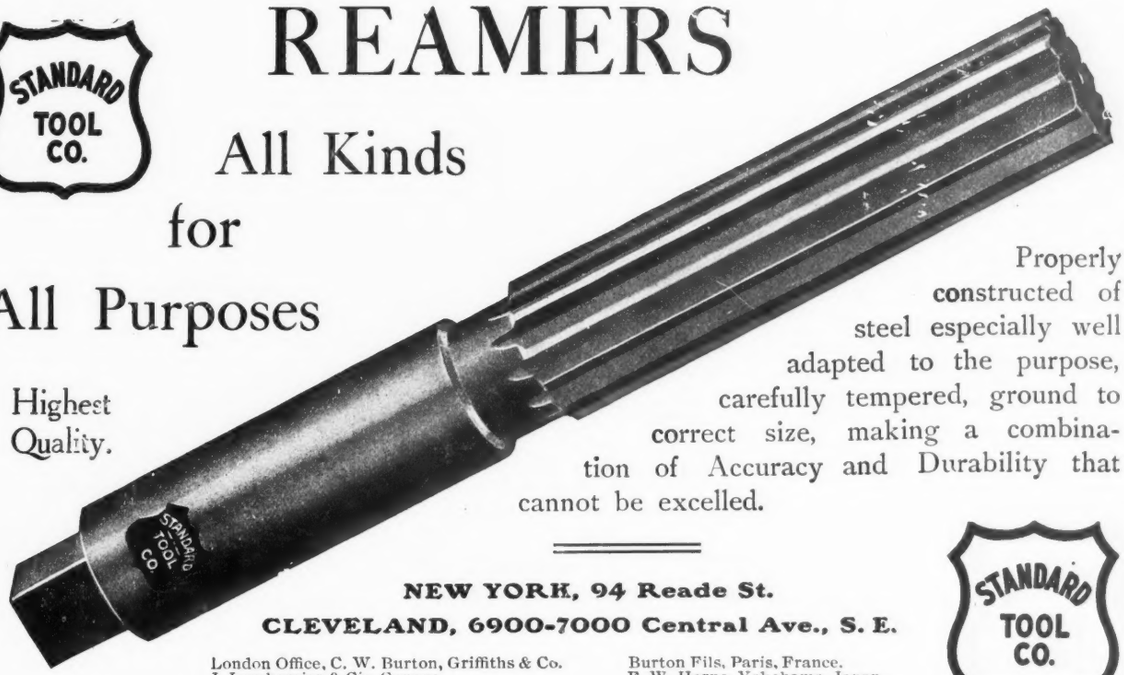
THE STANDARD TOOL CO.

REAMERS

STANDARD TOOL CO.

All Kinds for All Purposes

Highest Quality.



Properly constructed of steel especially well adapted to the purpose, carefully tempered, ground to correct size, making a combination of Accuracy and Durability that cannot be excelled.

NEW YORK, 94 Reade St.

CLEVELAND, 6900-7000 Central Ave., S. E.

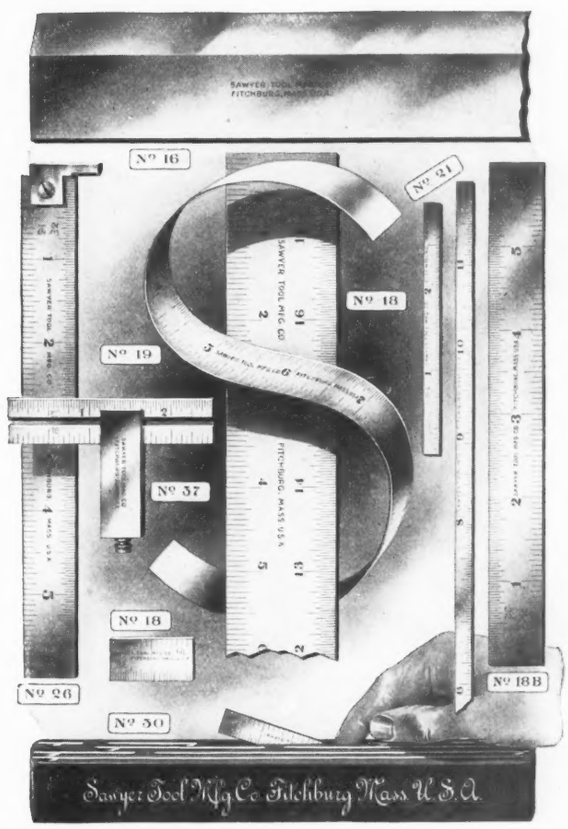
London Office, C. W. Burton, Griffiths & Co.
J. Lambercier & Cie, Geneve.

Burton Fils, Paris, France.
F. W. Horne, Yokohama, Japan.

STANDARD TOOL CO.

THE No. 19 Rule which resembles the letter "S" in the accompanying illustration is the Sawyer Flexible Spring Tempered Rule—made from watch spring stock—a handy rule for measuring curves or irregular surfaces. The two ends of a six-inch rule can easily be brought together without breaking it.

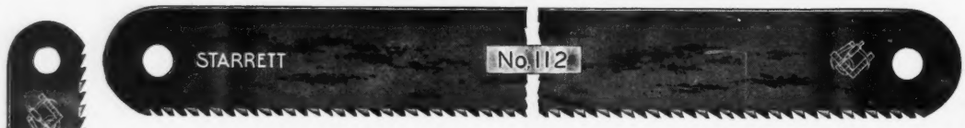
Write for catalogue of Machinists' Tools and insist that you see "Sawyer" make.

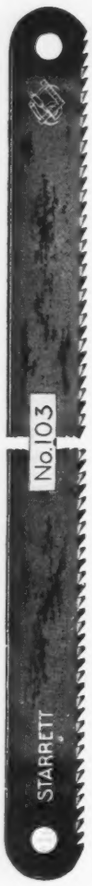


Sawyer

Tool Mfg. Co.

Fitchburg, Mass., U. S. A.





STARRETT HACK SAWS DON'T OFTEN SAVE LIFE

Miner Hicks and the Hack Saw

In the show window of a Hardware store down in Bakersfield, there is displayed a number of articles of clothing and tools used by Miner L. B. Hicks, who was entombed for fifteen days in the narrowest and darkest of subterranean cells in the heart of the mountains near Bakersfield.

Among the tools that are shown in the window is one that played a very important part in saving the man's life, so that he might live until his companions could reach him. This tool is Starretts Hack Saw Blade. When this man was buried seventy feet below the surface, and he was pinioned under a heavy car by iron rods, he used the Hack Saw to cut himself free, thus saving his life until more heroic measures could be taken.

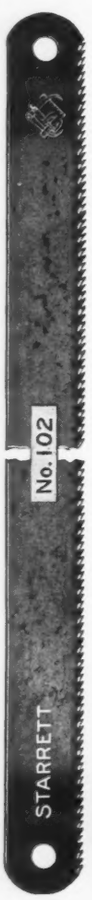
—*The Hardware Journal, San Francisco, Jan., 1907.*

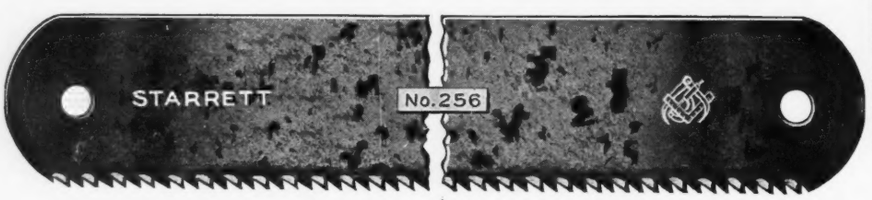
BUT THEY SAVE TIME AND MONEY EVERY DAY

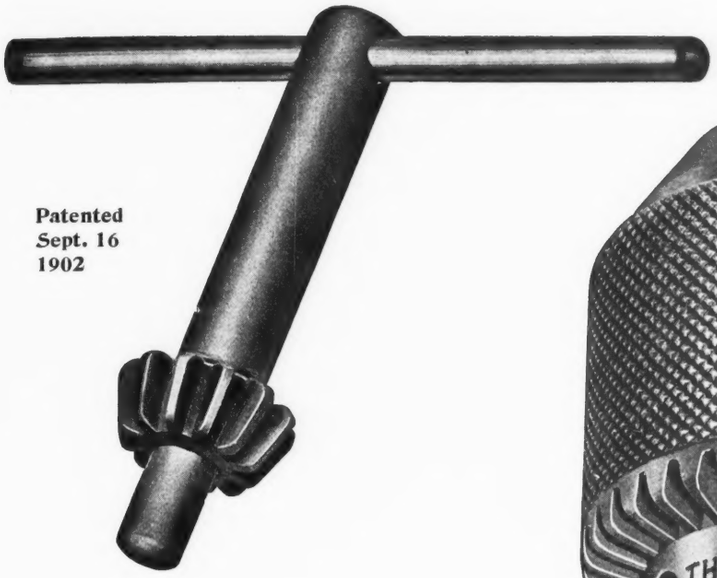
Ask for Catalog No. 17-D.

The L. S. Starrett Company, Athol, Mass., U.S.A.

NEW YORK CHICAGO LONDON







Patented
Sept. 16
1902

Jacobs Improved Drill Chuck No. 4

Why the Superintendent specifies Jacobs Drill Chucks

"The Jacobs Improved Drill Chuck is not only the most convenient, but after two years of service, has proven to be the most durable Drill Chuck we have ever used."

Superintendent of a large Fire Arms Concern

"We are constantly replacing old style chucks with the Jacobs Chuck, because the Jacobs Chuck is more handy to manipulate, is more powerful and more durable."

Works Manager, Pratt & Whitney Company

"I have always found the Jacobs Chuck superior to others, for it can be more positively tightened, and in my opinion is far more convenient, for the knurled sleeve can be used to bring the jaws of the Chuck down to the Drill, using the toothed key for the final tightening"

Superintendent Hartford Suspension Company

AND THERE "ARE OTHERS"

The Jacobs Chuck is now made in FIVE Sizes. Ask us for the book.

The Jacobs Manufacturing Company

HARTFORD, CONN., U. S. A.

The Practical Economy

of the

Favorite Reversible Ratchet Wrench

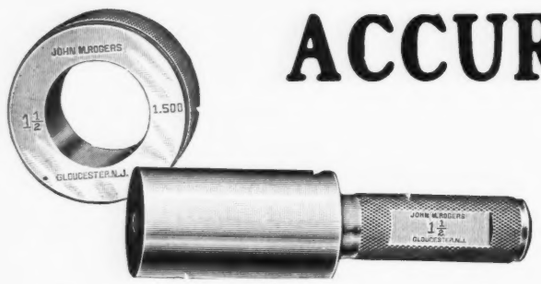
is becoming more generally recognized every day. It is simple, nothing to get out of order; durable, stands the hardest service; handles all sizes square or hexagon nuts by merely changing the heads, can be used in close quarters, instantly reversed, and motion is continuous till the nut is seated or removed.

Almost indispensable for construction work, or where many nuts of uniform size must be handled, and a time saver for the railroad or heavy machine shop work.

Write for circulars.

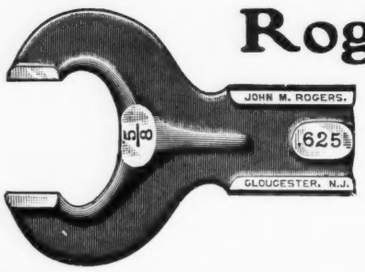
GREENE, TWEED & CO., 109 Duane St., New York, U. S. A.

ACCURATE GAUGES



As essential to the equipment of the modern machine shop as the engine lathe and high speed steel.

Our line of Gauges is backed by years of experience in the manufacture and use of precision tools; they are made from the best stock, carefully prepared, and are fully guaranteed.



Rogers Gauges

are made in a wide range of styles and sizes and will meet every and all requirements of machine shop practice.

Send for Catalogue No. 7 and our new List of High Speed Reamers.

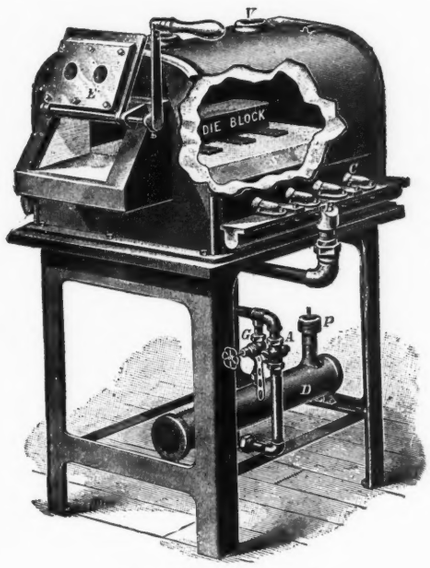
The John M. Rogers Works

Gloucester City, N. J., U.S.A.

ENGLISH AGENTS—Chas. Churchill & Co., Ltd., London, E. C. Selig, Sonnenthal & Co., London, E. C. C. W. Burton, Griffiths & Co., London, E. C. DeFries & Co., Dusseldorf, Germany. V. Lowener, Copenhagen, Denmark.

OVEN FURNACES

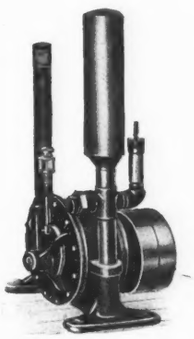
For Hardening and Annealing Metal Work



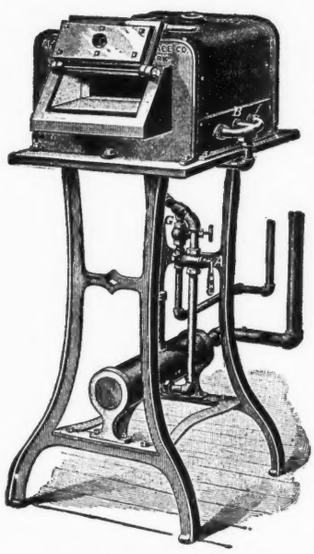
Oven Furnace No. 1

These furnaces are made in a wide range of sizes; are designed to heat square or oblong space of any desired dimensions to the required temperature and maintain a uniform heat under all conditions. The Oven Furnace is generally more satisfactory than a muffle furnace because there is a complete absence of oxidization. The No. 1 Furnace as shown, is adapted for general hardening and annealing—the No. 16-a smaller size, is much used in tool rooms for heating cutters, dies, lathe and planer tools and like work.

Air Blast under pressure of one pound to the square inch indispensable.



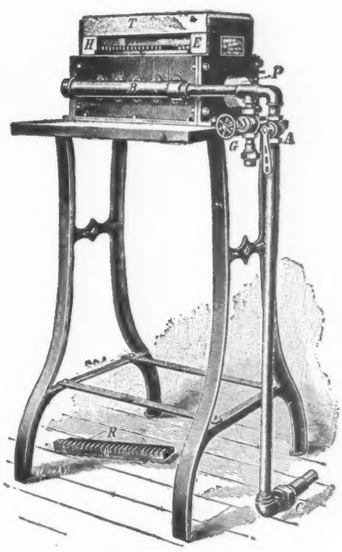
Positive Pressure Blower



Oven Furnace No. 16

"American" Gas Blast Forges

For the machine shop and tool room will heat the work quickly and uniformly, with little or no scale, and danger of overheating stock is practically eliminated. They are ready at all times, develop the required amount of heat in a few minutes and are both convenient and economical.



Gas Forge No. 7
For Cutlery, etc.

We shall be glad to forward Catalogue showing full line of Furnaces.

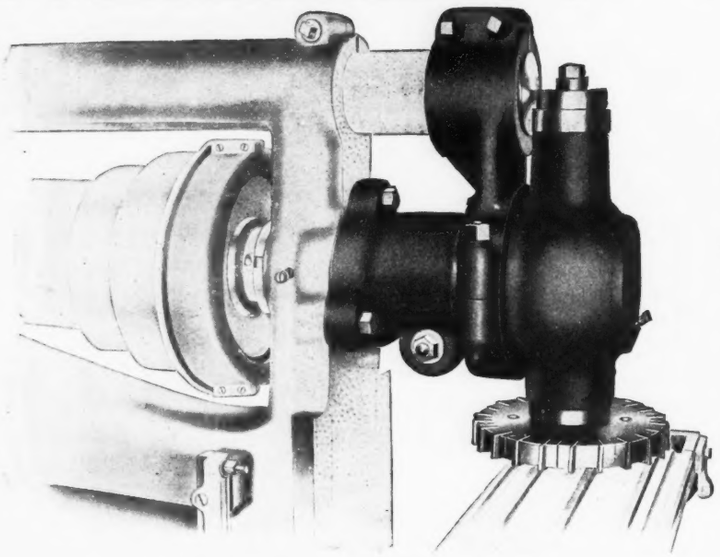
AMERICAN GAS FURNACE CO.

24 JOHN STREET, NEW YORK

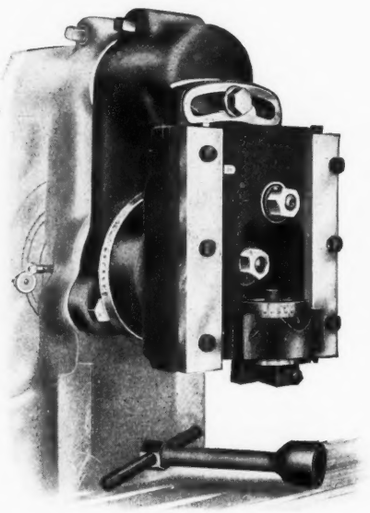
AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg, Stockholm. Alfred H. Schutte, Cologne, Brussels, Milan, Bilbao. Glaenzer, Perreaud & Thomine, Paris, for France and Switzerland. Chicago, Machinists' Supply Co., 16-18 South Canal St. St. Louis, W. R. Colcord Co., 811-823 North Second St., W. H. Kelsey & Co., 646 Prospect St., Cleveland, Ohio., and Gas Companies in nearly all Cities and Manufacturing Towns.

KEMPSMITH

MILLING MACHINE ATTACHMENTS



EXTRA HEAVY VERTICAL MILLING ATTACHMENT



SLOTTING ATTACHMENT

The attachments are capable of the full pulling power of the main spindle of the miller. These are only samples of the character of attachments we are able to furnish with our milling machines.

THE KEMPSMITH MFG. CO., Milwaukee, Wis.

European Agents: Selig, Sonnenthal & Co., London, E. C. Canadian Agents: London Machine Tool Co., Ltd., Hamilton, Ont.
Agents for Holland: R. S. Stokvis & Zonen, Rotterdam.

POWERFUL--RIGID--ACCURATE

MACHINE TOOLS

for

HEAVY DUTY

Prentiss Tool & Supply Co.

115 Liberty Street,
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Branch Offices:

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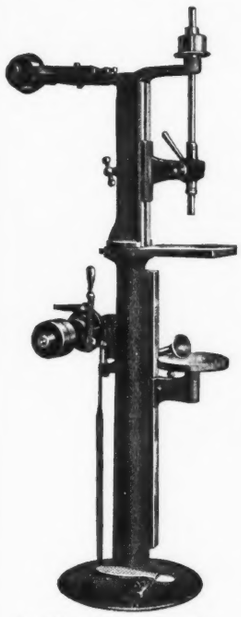
MONEY MAKERS IN THE MACHINE SHOP

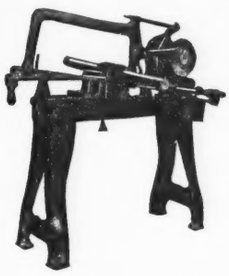
The Robertson Drill Presses and ..... Rapid Cut Saws



12-INCH SENSITIVE DRILL
It is a dandy for fast drilling.

That Universal table is worth a lot; you don't pay any more for it when you buy a Robertson, and the machine will pay for itself in a few days.

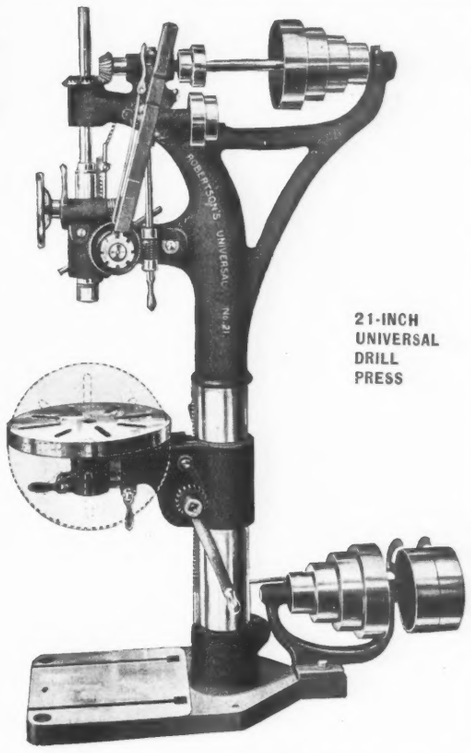
SOLD BY ALL THE LEADING DEALERS.



No. 3 Rapid Cut Saw

The kind that cuts fast and true. We make eight sizes.

BETTER ASK FOR THEM



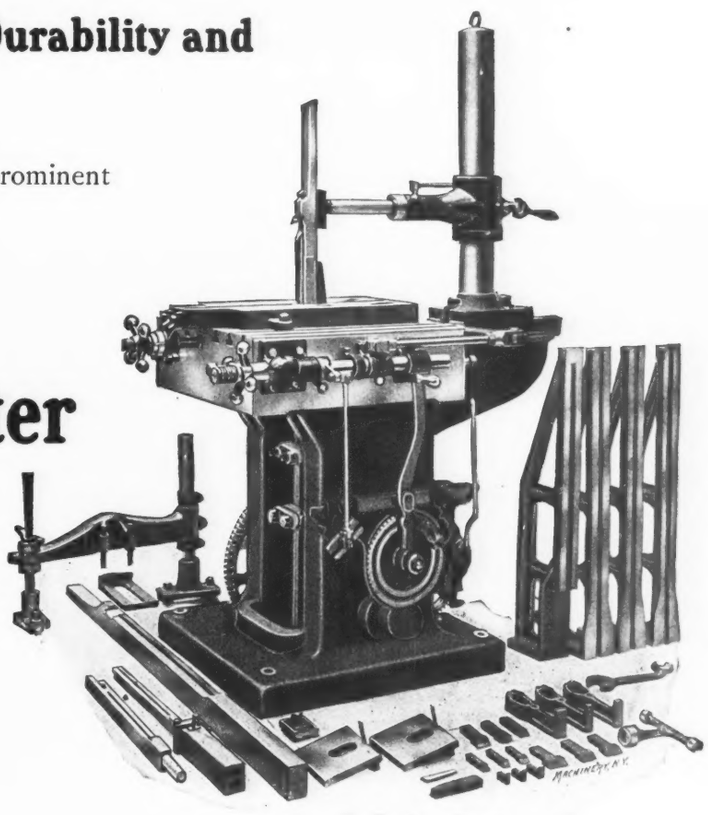
21-INCH UNIVERSAL DRILL PRESS

Made by **The Robertson Manufacturing Company,** BUFFALO, N. Y. U. S. A.

Rapidity, Accuracy, Durability and Ease of Operation

are the features most prominent in the

Morton Key Seater



It centers the work by the bore and can be set to cut a keyway of a given size and taper, without a rule and before it is placed on the machine.

Investigate the Morton

Morton Mfg. Co.

Muskegon Heights, Mich.

The "LIGHTNING" TAPPER TAP

Is the most used and best Tapper Tap on the market

MADE OF THE FINEST STEEL, CAREFULLY HARDENED AND TEMPERED

Give them a trial. Send for catalogue No. 33 E and prices

MADE BY

WILEY & RUSSELL MFG. CO., Greenfield, Mass., U. S A.

VANADIUM STEEL

WE RECOMMEND AND CAN FURNISH DIFFERENT GRADES OF THIS REMARKABLE STEEL FOR DIFFERENT PURPOSES

For Locomotive and Motor Axles
For Piston Rods and Crank Shafts
For Locomotive and Tender Springs
For Automobile Parts

Prompt Shipment of all Standard Sizes

COLONIAL STEEL COMPANY

PITTSBURGH, PA.

FIRTH STERLING STEEL COMPANY

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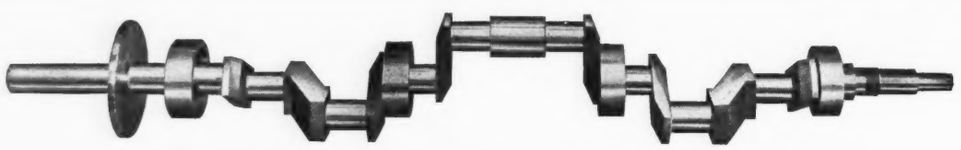
Manufacturers of High Grade Crucible Tool Steel

Have your tools made of BLUE CHIP STEEL and you will get satisfactory results



FINISHING MOTOR CRANK SHAFTS BY THE TINDEL SYSTEM OF LATHE AND GRINDING MACHINE

Beyond all comparison the cheapest way to finish motor crank shafts in quantity from the rough forgings, is by the use of the **Tindel-Albrecht Lathe** for rapid cutting down the rough forgings to grinding size and finishing in the **Tindel-Albrecht Special Crank Shaft Grinding Machine.** Cost of installation is less than any other. No accessory fixtures are required. The output is much the largest. The wear of grinding wheels is trifling. The accuracy of the work is unequaled. Write us for particulars.

THE TINDEL-MORRIS COMPANY, - EDDYSTONE, PENNSYLVANIA, U. S. A.

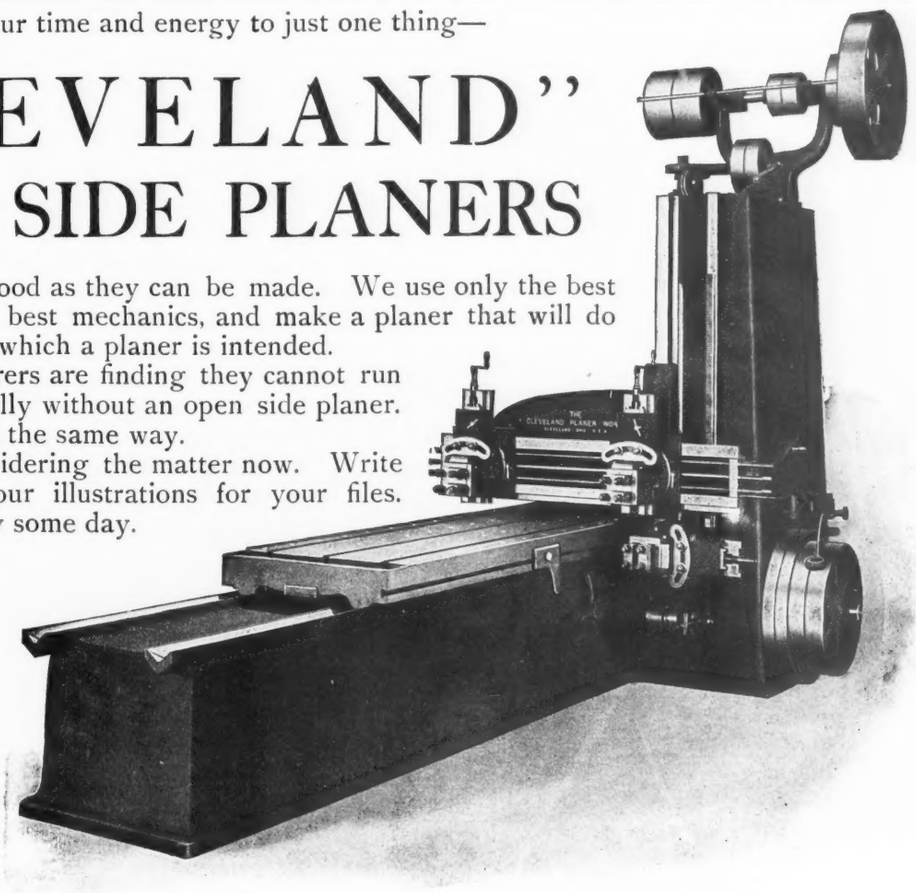
We are devoting all our time and energy to just one thing—

"CLEVELAND" OPEN SIDE PLANERS

—to make them as good as they can be made. We use only the best materials, employ the best mechanics, and make a planer that will do any class of work for which a planer is intended.

Many manufacturers are finding they cannot run their plants successfully without an open side planer. Many more will see it the same way.

You may be considering the matter now. Write us any way. Get our illustrations for your files. They'll come in handy some day.



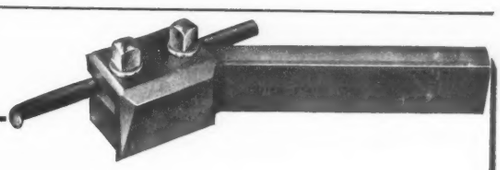
36 in. x 36 in. x 12 ft.

MANUFACTURED BY

Cleveland Planer Works

3150-3158 Superior Ave., N. E.

CLEVELAND OHIO, U. S. A.



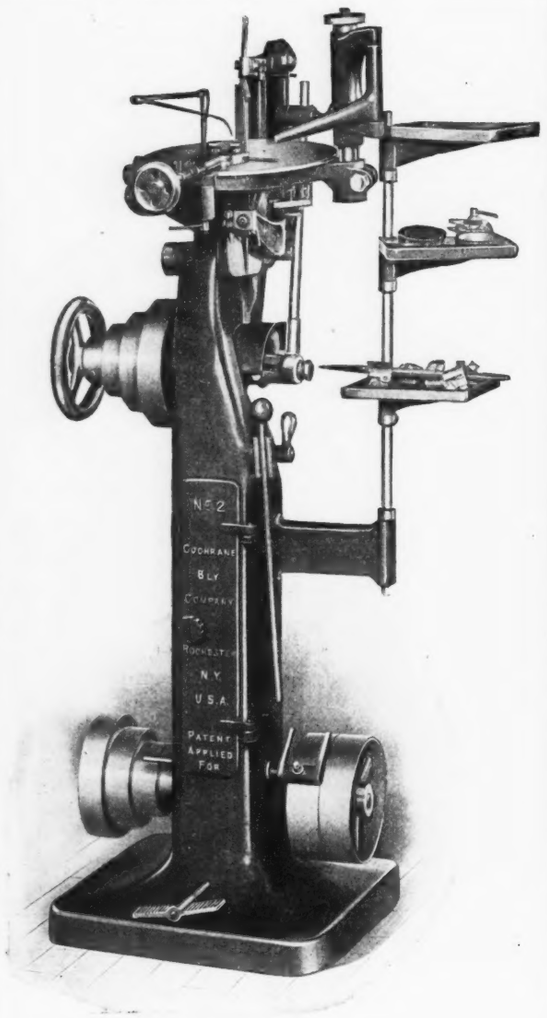
You Cannot Turn Out Good Work With Poor Tools

THE UNITED STATES BORING TOOL

excels all others in the convenience of using. The shank is very rigid. The head is designed for the use of boring cutters, drills, taps, reamers, etc., of a wide range of sizes. The cap will hold tools without slipping, *and will not mash down the shanks.* Our catalog tells more about them.

THE FAIRBANKS COMPANY

Springfield, Ohio



FOR DIE MAKING

and work requiring extreme accuracy, also for finishing small duplicate parts, use

The Cochrane-Bly Filing Machine

It is saving money in the best equipped shops.
The table tilts to give the exact angle and the filed surfaces are true. A coarse file gives a smooth finish and removes the stock very rapidly. An air pump blows away the chips.

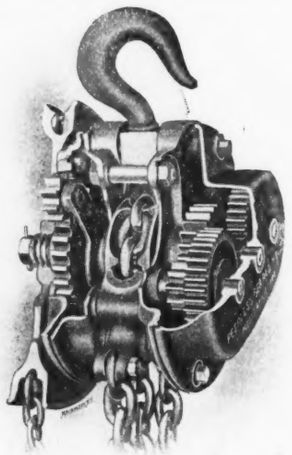
Ask for catalogue and list of representative users.

Cochrane-Bly Company
ROCHESTER, N. Y.

Ten Reasons why you want the

PEERLESS HOIST

1. Not *some* but *all* working parts are enclosed in dust-proof cases. This prevents wear and makes it smooth and easy running.

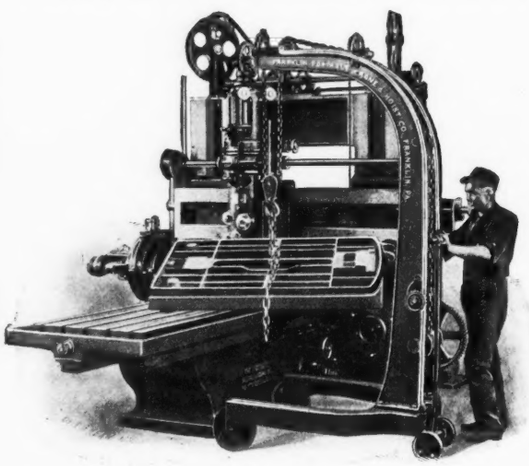


2. Light in weight.
3. It is noiseless in operation.
4. It lifts quickly.
5. The load is sustained by a friction that neither jams nor slips.
6. All gears are Spur Gears—made of steel with cut teeth.
7. All parts are interchangeable.
8. Each one is thoroughly tested and is absolutely safe.
9. Sizes from 500 to 40,000 lbs. capacity.
10. Your dealer will send one on 30 days' trial—we know you'll be satisfied.

EDWIN HARRINGTON, SON & CO.
Incorporated
PHILADELPHIA, PA.

The Price of a Franklin Portable Crane and Hoist

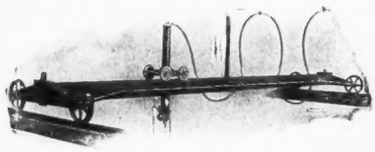
is small enough to put it within the reach of any shop or factory, and its usefulness will soon wipe out the cost.



Can be handled by one man. Lifts and carries loads of any shape or size up to two tons weight. Compact, convenient and one of the time and labor savers of the day. Send for booklets and new discount.

Franklin Portable Crane & Hoist Co.
FRANKLIN, PENNSYLVANIA

THE CURTIS
Light Bridge Crane with Curtis Air Hoists



AIR HOISTS IN STOCK
PNEUMATIC ELEVATORS
AIR COMPRESSORS

Curtis & Co. Mfg. Co., St. Louis

AGENTS: A. E. Hoermann, 41 Park Row, New York. Hill, Clarke & Co., Boston. Baird Machinery Co., Pittsburg.

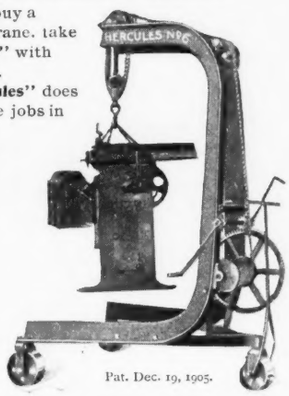
Hercules Portable Crane and Hoist
The Modern Model

When you buy a Portable Crane, take a **"Hercules"** with Steel frame. The **"Hercules"** does all the crane jobs in the quickest, easiest way, with least labor.

Standard Sizes.

Specials to Order.

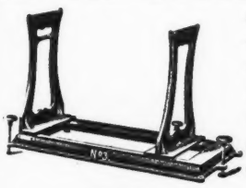
Circular on request.



Pat. Dec. 19, 1905.

William S. Nicholls, 254 Broadway, New York

An Absolute Level in Ten Seconds



Compare this with the old way—ten to twenty minutes saved, and results certain.

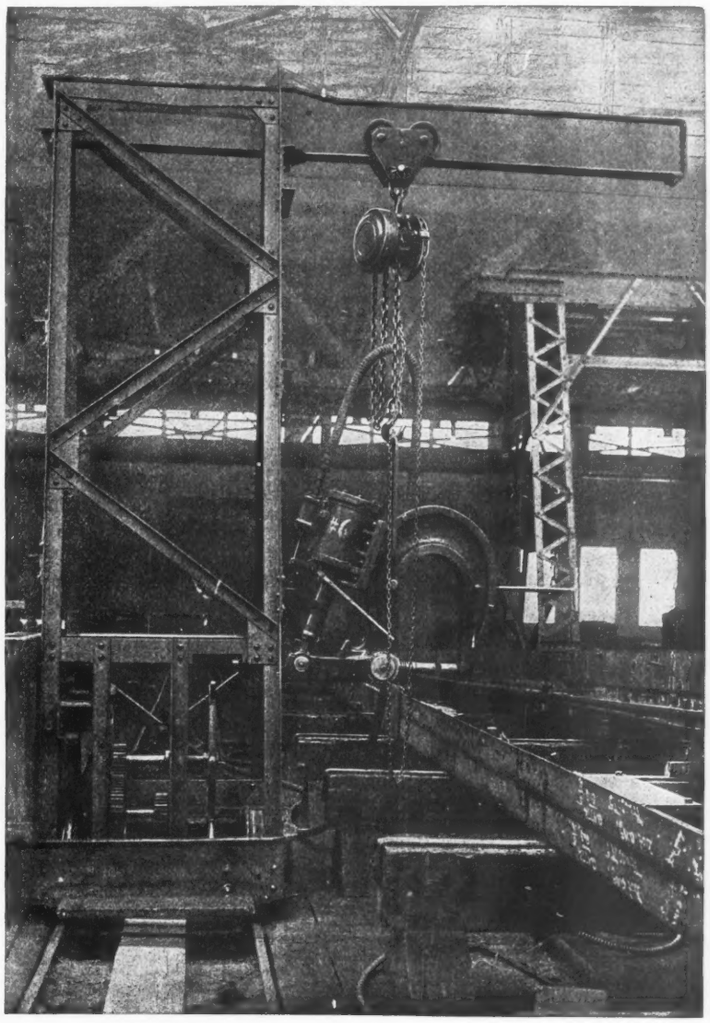
Bowsher's Patent Balancing Way
Is the New Way

Made in 3 sizes and styles, for bench and floor use. Ways chilled and ground, spirit levels attached.

Circular "BW" for details.

The N. P. BOWSHER CO.
South Bend, Ind.

Fenwick Freres & Co., Agents, Paris.



Y & T CHAIN BLOCKS
For Handling Machinery

This illustrates a TRIPLEX chain block on a track crane in a structural shop handling a pneumatic riveter.

Delicate machines require careful, safe handling. Economy demands speed. The sturdy construction and automatic brake make the TRIPLEX perfectly safe. The spur-geared mechanism and elimination of brake friction make it very fast. Oftimes a block on a short I-beam for installing machinery will save its cost in a day or two,

Sometimes a plant needs one chain block—sometimes a hundred would be a profitable investment. We have had large experience in planning hoisting systems. This experience is at your service for the asking. Give us some data regarding your work—size of plant, kind of goods, weight of loads, average height of lift, and distance to be transported. We will tell you what Y & T Chain Blocks and Electric Hoists will do for you—and at what cost.

Chain Blocks—⅛ to 40 tons.
Electric Hoists—1 to 30 tons.

The Yale and Towne Manufacturing Co.

9 MURRAY STREET, NEW YORK

FOREIGN WAREHOUSES:—Fairbanks Co., London and Hamburg. Fenwick Freres & Co., Paris. Alfred H. Schutte, Koln a Rh. F. W. Horne, Yokohama, Japan.

SHAW

Cranes have led in every step of progress in the crane industry. The First Multi-motor Electric Traveling Crane ever built was a SHAW—the First to adopt the steel cable in place of the chain was the SHAW, and the First in every feature of advantage, efficiency, durability and economy IS the SHAW. Wherever you find a SHAW you find the Best of

CRANES

NEVER BUY A CRANE BEFORE INVESTIGATING THE SHAW

MANUFACTURED BY

SHAW ELECTRIC CRANE CO.

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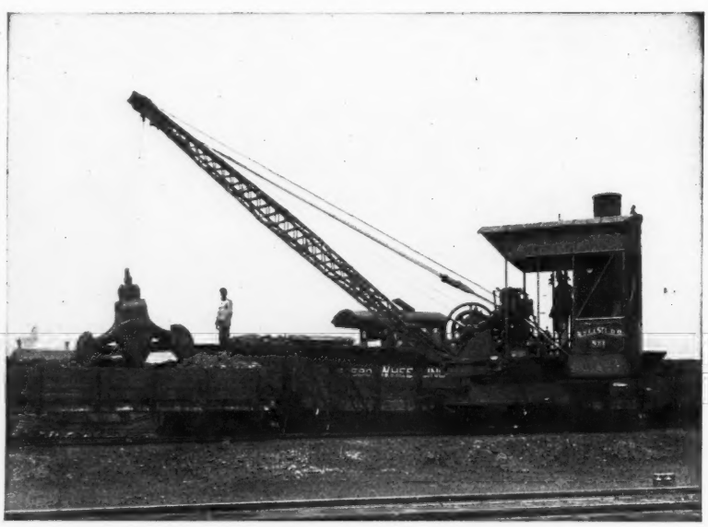
MANY FIRMS HAVE FOUND A

"BrownHoist" Locomotive Crane

the most profitable tool about their yards. Equipped with grab buckets or without.

Manufacturers of Hoisting Machinery for all Devices



Manufacturers of Hoisting Machinery for all Devices

We would be pleased to demonstrate their utility to you.

The Brown Hoisting Machinery Company

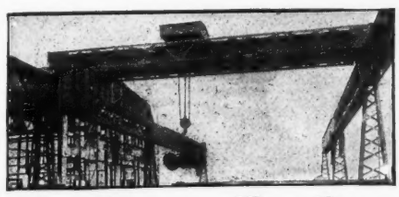
Office and Works, Cleveland, Ohio, U. S. A.

BRANCHES: PITTSBURG AND NEW YORK

ALL KINDS
ALL CAPACITIES
Get Catalogs

NORTHERN CRANES

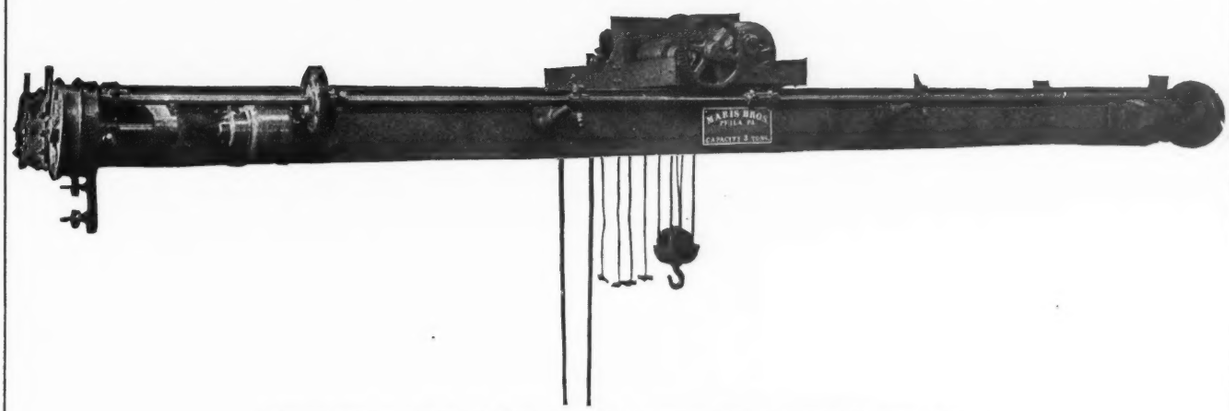
Electric
Direct
or
Alternating
Current



ELECTRIC HOISTS
Get Prices

Northern Engineering Works, 26 Chene St., Detroit, Mich.
New York: 120 Liberty Street Philadelphia: Land Title Building Chicago: 405 Monadnock Block

CRANES ELECTRIC & HAND
OPERATED FROM THE FLOOR



3 tons, 2 motors. Hoist and Bridge motion by power. Trolley motion by hand chain.

A handy crane for erecting floors in machine shops and for all service where loads are to be handled quickly and at low cost. Made with one, two or three motors, for power hoist, power hoist and bridge travel, or power hoist, bridge and trolley travel.

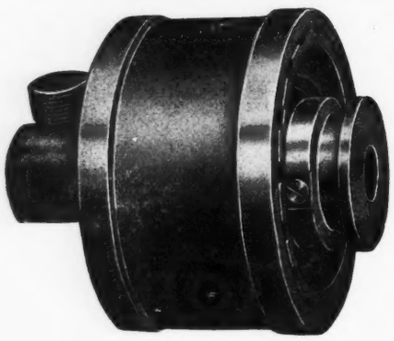
MARIS BROS.
56th St. and Gray's Ave., PHILADELPHIA, PA.
Manning, Maxwell & Moore, Inc., Agents, New York—Pittsburg—Chicago—Boston—Cleveland.

TRAVELING
CRANES
AND
HOISTS
1-4 Ton to 200 Tons Capacity

2000 MACHINES IN USE.

Repeated orders from extensive users prove our claims for superior design, workmanship and completeness in all details. We manufacture and assemble every part and test the complete machine before shipment.

PAWLING & HARNISCHFEGER, - Milwaukee, Wis.

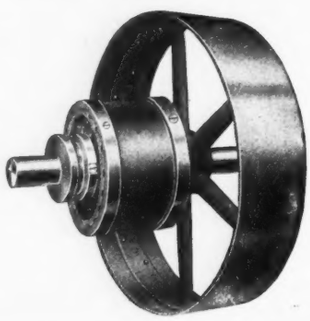


A Little List of Akron Friction Clutch Advantages

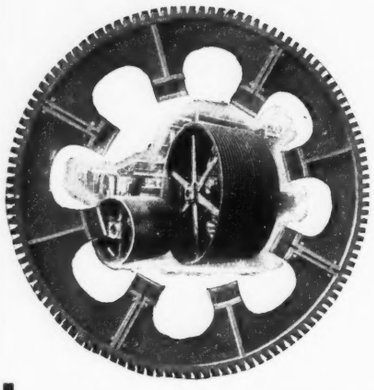
Simple, compact, easy to adjust.
No special pulley required.
Action, smooth and positive.
Runs noiselessly and without vibration.
Needs no attention beyond oiling.
Light in weight and takes up very little room on the shaft.
Starts the machinery instantly or gradually as desired.
Will slip automatically when the load exceeds the horse power of clutch.
Will positively do the work on extremely low or extremely high speed shafts where other clutches have failed.
Stands rough usage. All working parts protected from dust and dirt.
Especially adapted for driving machine tools, dynamos, gas engines and for other service where a powerful clutch is required.

Glad to send full details.

Akron Clutch Company
AKRON, OHIO
Successors to Williams Electric Machine Co.



Power-Transmitting Machinery

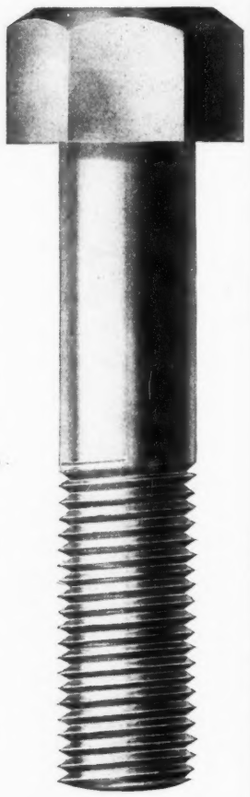


We design and install complete rope drives. Our machine-molded sheaves are perfect in balance, accurately finished and free from flaws injurious to the rope. Rope drives designed by us are successful.

We cast and finish Sheaves (English or American System), Pulleys, Band Wheels, Fly Wheels, Gears, Sprocket Wheels, etc. We manufacture Shafting, Pillow Blocks, Hangers, Floor Stands, etc.

H. W. Caldwell & Son Co.
CHICAGO: Western Avenue, 17th-18th Street.
NEW YORK: 95 Liberty Street.
Woodward, Wight & Co., Ltd., New Orleans.

FINISHED STEEL
Screws AND Bolts



In the larger sizes—regular and special—made from steel of the best quality, guaranteed accurate, stronger and better than any you have ever used.

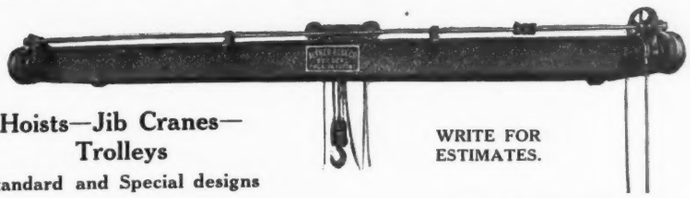
The electric welding process places us in a position to be of decided service to you

Some of you have been slow about figuring with us.

Don't you care about saving the dollars and cents coming to you?

THE CLEVELAND CAP SCREW CO.
CLEVELAND, OHIO

Electric and Hand Power Cranes



Hoists—Jib Cranes—
Trolleys
Standard and Special designs

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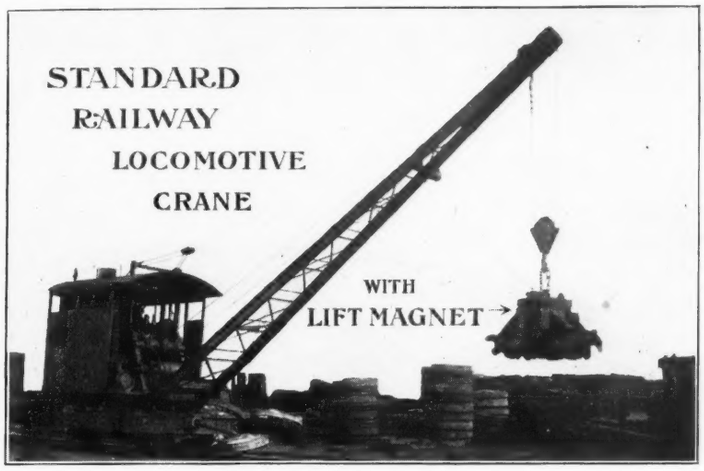
Alfred Box & Company, - Philadelphia, Pa.

STANDARD
RAILWAY
LOCOMOTIVE
CRANE
WITH
LIFT MAGNET



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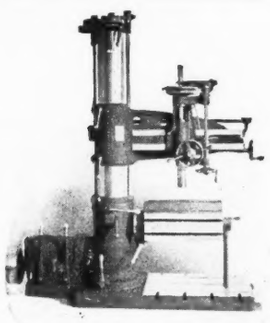
Browning Standard Locomotive Cranes with Clam Shell Bucket or Lift Magnet

THE BROWNING ENGINEERING COMPANY
CLEVELAND, O.



Mueller Radial Drills

are noted for their rapid production of high grade work. The improved design includes every feature for efficient operation. The stationary column insures the utmost rigidity to the work spindle. 16 spindle speeds are under instant control of the operator. Wide range of feeds. One lever serves to start, stop or reverse the spindle, and also to raise or lower the arm.

Write for latest Catalogue.

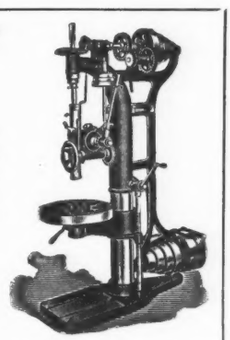
Mueller Machine Tool Co.
216 W. PEARL ST., CINCINNATI, O.

A Good Drill Press is a Tool of Many Uses.

A SIBLEY DRILL in your shop is rarely idle. With proper jigs these machines will accomplish a very large amount of work at a very low labor cost. They are rapid, accurate, have a wide range, are adapted for light or heavy work as occasion requires, and are fitted with all the latest improvements.

Write for Catalogue showing Styles and Sizes of Power Drills.

Sibley Machine Tool Co., South Bend, Ind.
Successors to Sibley & Ware.



13" DRILL PRESS No. 30

Strong
Accurate

Will drill
½" holes
easily.

Francis Reed Co.
WORCESTER
MASS., U. S. A.

The Knight Drilling and Milling Machine

From 20 to 50 per cent. saved in making dies, jigs, cams, models, patterns, and in circular, experimental and tool room work.

Send for catalogue.

MANUFACTURED BY THE
W. B. Knight Machinery Co.
2019–2025 Lucas Ave., ST. LOUIS, MO.

Bound Volumes of Machinery
Vol. 12 -- 1905-1906 now ready.
The Industrial Press, New York.

TEMPER

in a Twist Drill is a good deal like temper in a man. If it is not even the drill will not stand up to the work it is called upon to do; it soon goes to pieces. But when the temper is just right the best results are obtained from either man or drill. In making "Diamond" Twist Drills special attention is given this essential feature with the result that they wear longer, do more work with less grinding and show less breakage than any other **Twist Drills.** Selected stock, proper milling, correct clearance and grinding, also help to make "Diamond" Twist Drills the best on the market.

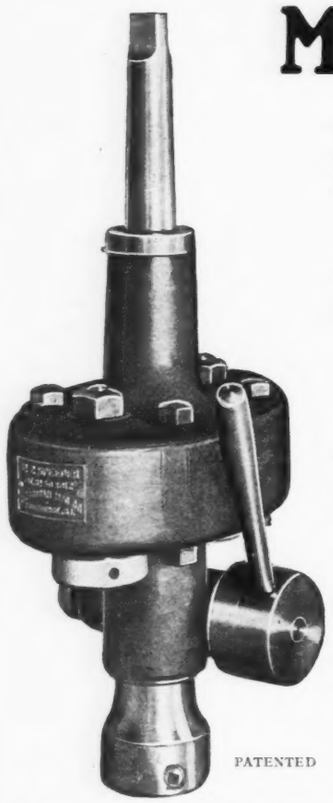
W B TRADE MARKS W&B

The Whitman & Barnes Mfg. Company

Factories: Akron O. Chicago, Ill. St. Catharines, Ont.
General Sales Office: Chicago, Ill. New York Office: 59 Center Street

Export Representative:
A. J. BARNES, 90 West Street, New York.

European Representative:
THEO. BUTLER, 149 Queen Victoria Street, London, Eng.



PATENTED

Mr. Superintendent—

If you will spend but **ONE MINUTE** each day in noticing the operator trying to drill small holes in a large press it will not be long before we have an order for one of our

Drill Speeders.

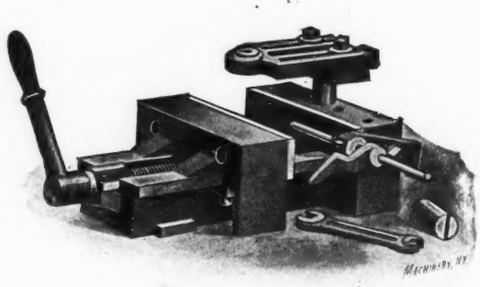
They increase the speed of small drills to what it should be, without overspeeding the main machine, and they have sensitive feeds and safety frictions to tell just what the drill is doing.

Try to run a 3-16" drill at 1000 R. P. M. and feed it with a coarse mechanism and you will appreciate what we are driving at..

Graham Drill Vise

Always a good vise for general shop use and at the same time holds work for duplicate drilling without the cost of a jig.

Write for circular.



The Graham Mfg. Co., Providence, R. I.

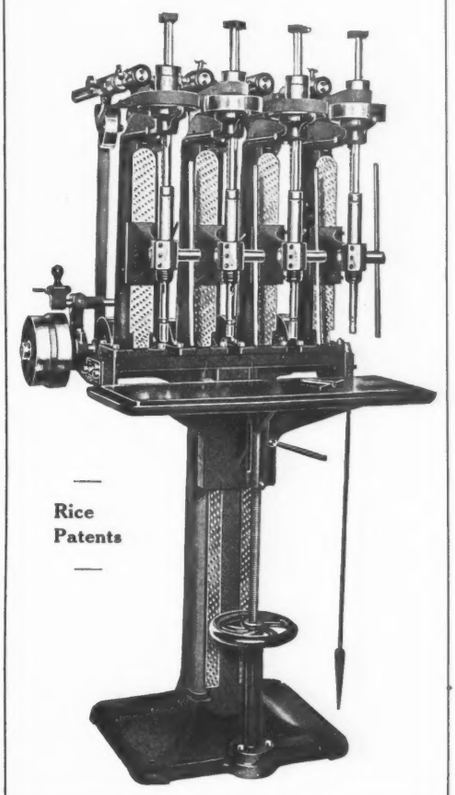
THE TOOL THAT WILL REDUCE YOUR DRILLING COSTS

The Henry & Wright Ball Bearing Drill

The most popular drilling machines on the market because they "make good" on all essential points. Stronger and heavier than other machines of like capacity. Require less power for operation. Ball bearing construction eliminates friction and makes them practically indestructible. The belt system is so simple and oiling so infrequently needed that the minimum attention on these points is required. They are built on the interchangeable plan, are especially adapted for high speed steels, and will drill from 200 to 400 per cent. more holes in a given time than any other drill using the same amount of power.

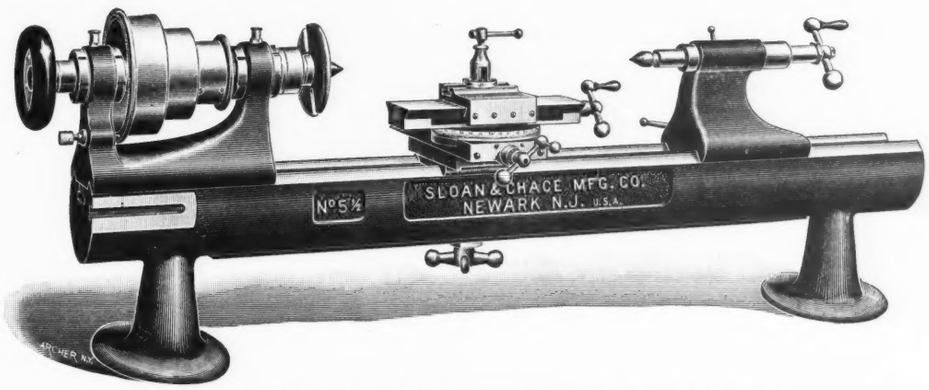
DRILL BOOK FOR THE ASKING

The Henry & Wright Mfg. Co.
HARTFORD, CONN., U. S. A.



Rice Patents

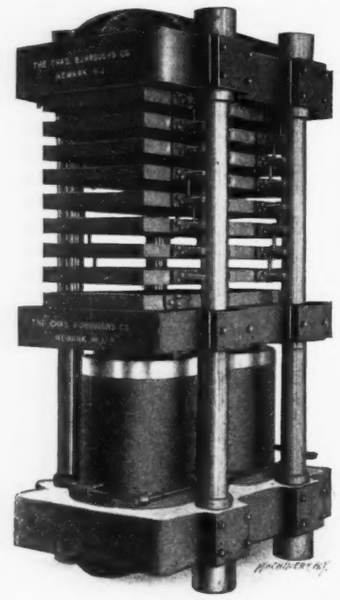
No. 5½ Sloan & Chace Bench Lathe



7-in. Swing. 35-in. Bed. 18-in. between Centers. ⅝-in. Chuck Capacity.

A new size in our line of Precision Lathes, with improved form of bed, adding to its strength and rigidity, off-set tail stock, and increased capacity of split collet. These machines insure the acme of accuracy, yet are strongly built and will stand severe service. They are designed with every convenience for rapid handling, and save time and labor in the general everyday work as well as in special high grade manufacturing. *Write for Bulletin. We build a complete line of Precision Tools.*

Sloan & Chace Mfg. Company, Ltd.
NEWARK, N. J., U. S. A.



Multiple Steam Plate Press

BURROUGHS HYDRAULIC MACHINERY

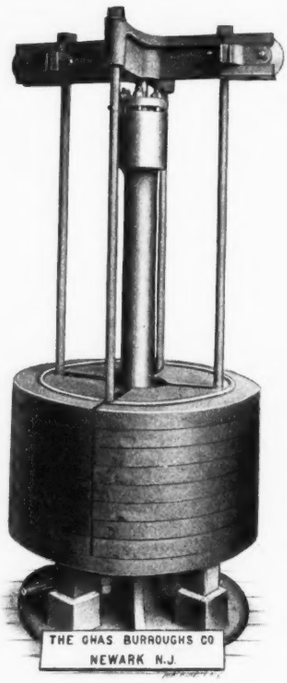
EVERY STYLE
FOR EVERY PURPOSE

There is an individuality of design, a quality, and a grade of efficiency about our machines that will interest you.

ESTIMATES GIVEN
SPECIAL DESIGNS

The CHARLES BURROUGHS COMPANY

141-149 Commerce Street
NEWARK, NEW JERSEY



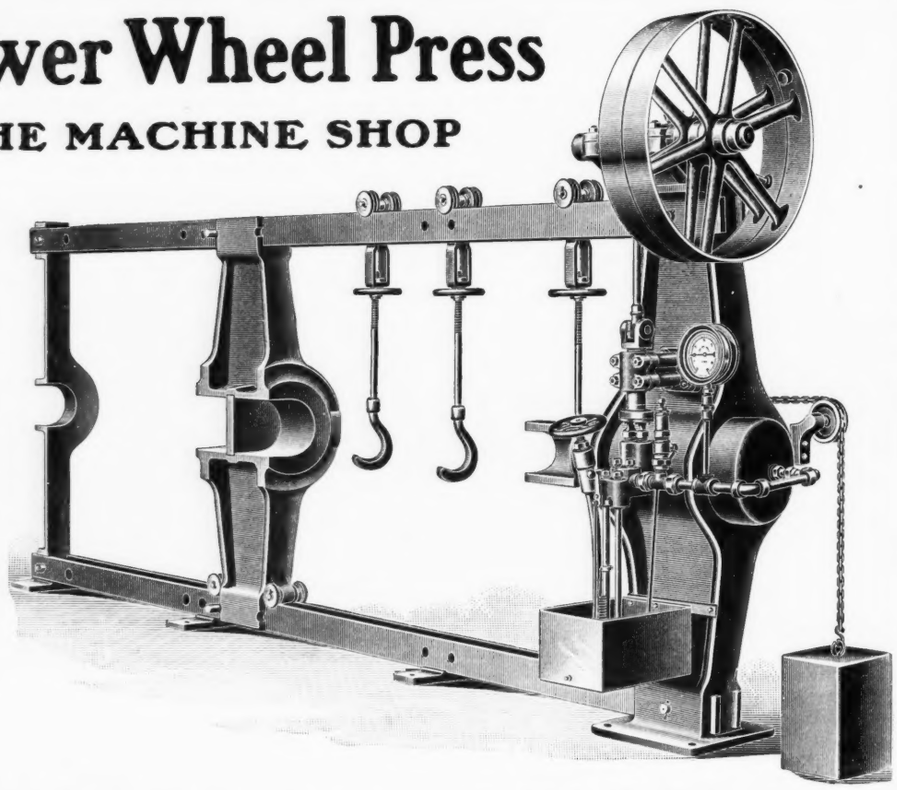
Weighted Accumulator

Belt Power Wheel Press

FOR THE MACHINE SHOP

An improved type of press with four rods—two at top and two at bottom—an arrangement which permits handling larger work than is practicable with the two rod type, and overcomes the eccentric strains that would otherwise result when work is not trued up. Three speeds can be obtained from the pump which is of the plunger type, and the Press is provided with all necessary valves, gauges, etc.

Special Circular sent on request.



The Watson-Stillman Company, 26 Cortlandt St., New York
CHICAGO OFFICE, 453 ROOKERY

COATES

Unit-Link Flexible Shafting

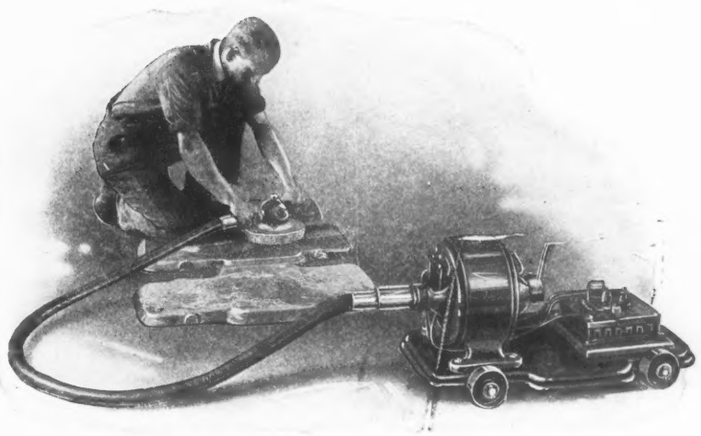
Send for book 20 H.

Did you ever watch a man with a chunk of an emery wheel "*worrying*" down by hand a casting trying to clean it up?

They cleaned castings that same way 400 years ago.

Why not do it four times as good and *four* times as quick by machine.

Use a drill, scratch brush, surfacing or snagging wheel on the same outfit.



COATES CLIPPER MFG. CO., Worcester, Mass., U. S. A.

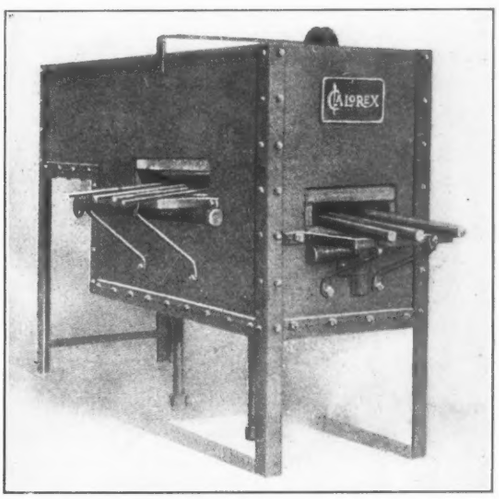
Calorex Fuel Furnaces

(a) Compressed air to thoroughly atomize the oil.

(b) Fan Blast to furnish air for combustion.

(c) Fan shaped combustion chamber—outside of charging space, in which the atomized oil and oxygen are thoroughly united, and by which the products of combustion are distributed over the charging space of furnace.

(d) Curved form of furnace roof, which imparts reverberatory movement to the heat.



Class "G" "Calorex" Liquid Fuel Furnace for rivet making and bolt heading.

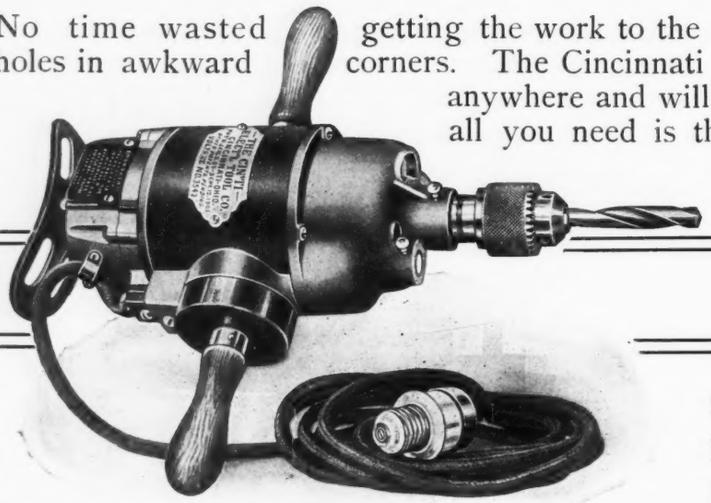
W. N. Best American Calorific Company,

11 Broadway, New York, U.S.A.

THEY GET RIGHT DOWN TO BUSINESS

Those PORTABLE ELECTRICAL DRILLS of ours

No time wasted getting the work to the machine—no trouble to drill holes in awkward corners. The Cincinnati Electrical Drill can be taken anywhere and will handle any kind of drilling—all you need is the connection with an incandescent lamp socket and you are ready to begin operations.



Save time—save bother—
Save money—Air cooled—
Direct current.

Same advantages apply to our Electrical Tool Post Grinder. Write for Bulletin P-4.

THE CINCINNATI ELECTRICAL TOOL COMPANY

CINCINNATI, OHIO, U. S. A.

New York Office:
95 Liberty Street.

EUROPEAN LICENSEES:
Selig, Sonnenthal & Co., London, who carry stock

IT IS NOT THE PRICE, BUT THE WORTH

Van Dorn "Hard Service" Portable Electric Drills and Reamers

ARE WORTH THE PRICE

Manufactured by.... **The Van Dorn Electric & Mfg. Co.** CLEVELAND, OHIO

CARPENTER'S ROUND DIE SET

with

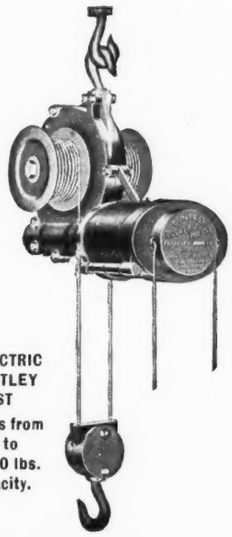
Carpenter's Patent Adjustable Die Stock and Nichols Tap Wrench.

No collets required with the Carpenter Stock. Jaws remain in any position to which adjusted.

Ask for catalog, "Tools for Cutting Screw Threads."

The J. M. Carpenter Tap & Die Company

Trade C Mark PAWTUCKET, R. I. Trade C Mark

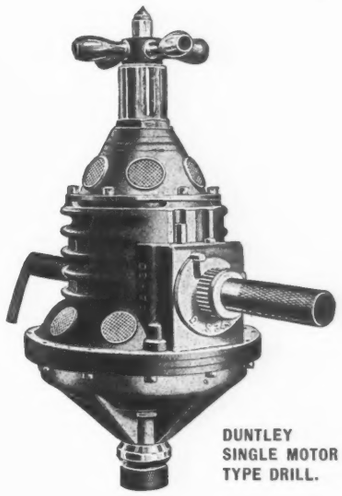


ELECTRIC DUNTLEY HOIST
Sizes from 250 to 2000 lbs. capacity.

IT'S THE DISCRIMINATING MAN

The man who thoroughly and carefully inspects every detail of tool construction from outer casing to innermost working part

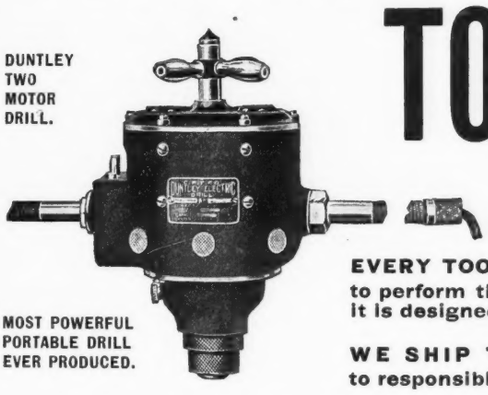
WHO ALWAYS BUYS



DUNTLEY SINGLE MOTOR TYPE DRILL.

DUNTLEY AIR COOLED PORTABLE ELECTRIC TOOLS

Write for Catalogue.



DUNTLEY TWO MOTOR DRILL.

MOST POWERFUL PORTABLE DRILL EVER PRODUCED.

WE MAKE THEM IN ALL SIZES

EVERY TOOL IS GUARANTEED to perform the service for which it is designed.

WE SHIP THEM ON TRIAL to responsible parties any where.

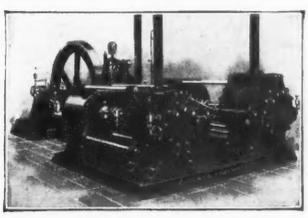
DUNTLEY ELECTRIC GRINDER
Built in Two Sizes.

WOUND FOR ALTERNATING OR DIRECT CURRENT.

FRANKLIN AIR COMPRESSORS

Are being built and installed at the rate of

60 PER MONTH



STEAM DRIVEN FRANKLIN AIR COMPRESSOR.

We build them in more than

100

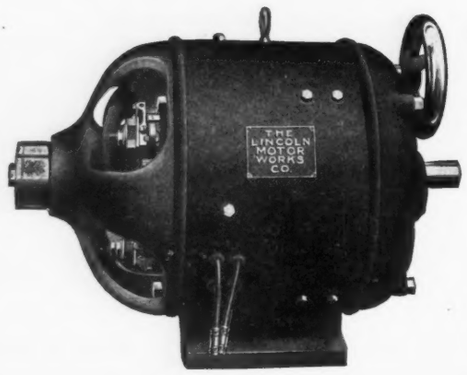
STYLES AND SIZES

CHICAGO PNEUMATIC TOOL COMPANY

Fisher Building
CHICAGO

95 Liberty Street
NEW YORK

We manufacture "Boyer" and "Keller" Riveting, Chipping and Calking Hammers, "Little Giant" Air Drills and a complete line of pneumatic tools and appliances.



HAND WHEEL OR SPROCKET FOR SPEED CONTROL

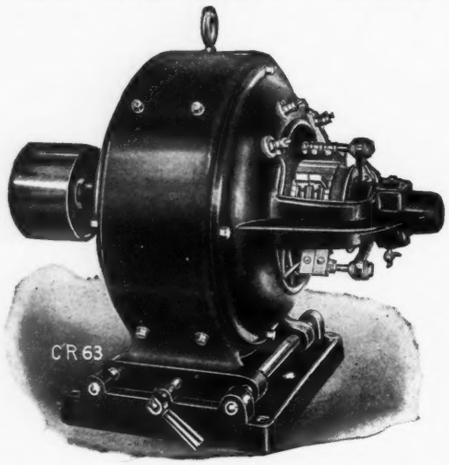
LINCOLN
Variable Speed Motors

No Controller. Wide Speed Ranges. Constant H.P.
Light Weight. Cool Running.

Any speed obtained at will, and when set for such speed it is maintained constant under varying load. **The ideal motor for individual motor drive.**

The Lincoln Motor Works Co.
Caxton Building, CLEVELAND, OHIO

"The Standard" Motors



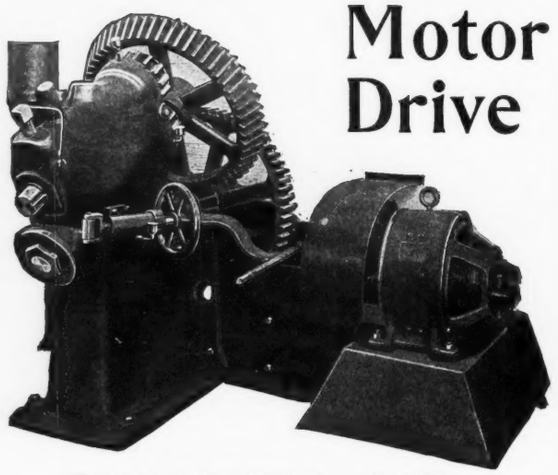
We are making 20 Standard Motor Frames for all kinds of work—open, gauze enclosed or solid enclosed, vertical shaft, back geared, variable speed, with sliding base, or with broad, flat, planed feet—in short, any kind of Motor you want of 15 H.P. to 1-30 H.P.

We have made over 16000 of these standard Motors, and we know the small Motor business as few ever can. "The Standard" Motors are made right. Our engineering advice is yours for the asking; state your case.

The Robbins & Myers Co.,
Main Office and Works: SPRINGFIELD, OHIO.

New York: 145 Chambers St.
Boston: 220 Purchase St.
Philadelphia: 1103 Arch St.
Dallas: Opera House Bldg.
Cleveland: 337 Frankfort Ave., N.W.
Baltimore: 221 Park Ave.
Chicago: 1107 Fisher Bldg.
St. Louis: 11th and Locust St.
Los Angeles: 278 So. Main St, and 111 E. Third St.
San Francisco: 319 Howard St.

Westinghouse
Motor Drive



Westinghouse Motor Driving Lenox Bevel Shears.

All of the advantages of electric drive may not apply to all machines,
But some of the advantages will apply to all machines,
And all of the advantages will apply to some machines,

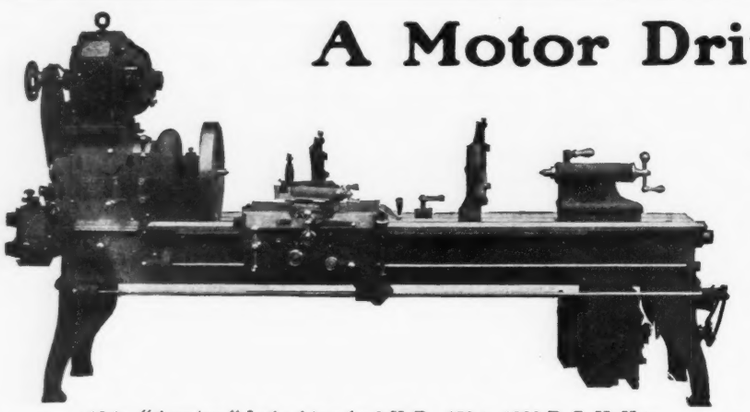
Send for a copy of our Application Folder No. 32.

Westinghouse Electric & Mfg. Co.

Atlanta	Cincinnati	Kansas City	Pittsburg
Baltimore	Cleveland	Los Angeles	St. Louis
Boston	Dallas	Minneapolis	Salt Lake City
Buffalo	Denver	New Orleans	San Francisco
Chicago	Detroit	New York	Seattle
		Philadelphia	Syracuse

Canada: Canadian Westinghouse Co., Ltd., Hamilton, Ontario
Mexico: G. & O. Braniff & Co., City of Mexico

A Motor Driven Lathe



18-in. "American" Lathe driven by 3 H. P., 450 to 1800 R. P. M. Motor.

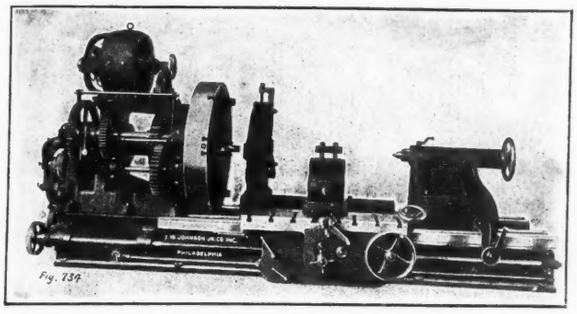
Has "the call" over a belt driven machine every time and when the motive power is a **Thompson-Ryan Variable-Speed Motor** the equipment approaches the ideal.

Some advantages of the Thompson-Ryan are: Wide range of speed variation. Field control, requiring no complicated controller or complex wiring. Sparkless commutation. Uniform speed.

Write for bulletin on machine tool drive.

Ridgway Dynamo & Engine Co.
Ridgway, Pa.

When Tired of Motor Troubles



Lathe Driven by Form I-F Motor.

Use **C-W** motors. They are built especially for machine tools by EXPERTS with 18 years' experience. Bulletin 64R and 78R explain them in detail.

CROCKER-WHEELER
COMPANY
AMPERE, N. J.

INDIVIDUAL MOTOR DRIVE

FOR MACHINE TOOLS

Will save 25 to 50 per cent. on your power cost. It will increase the productiveness of your plant. These are questions which should be of vital importance to you.

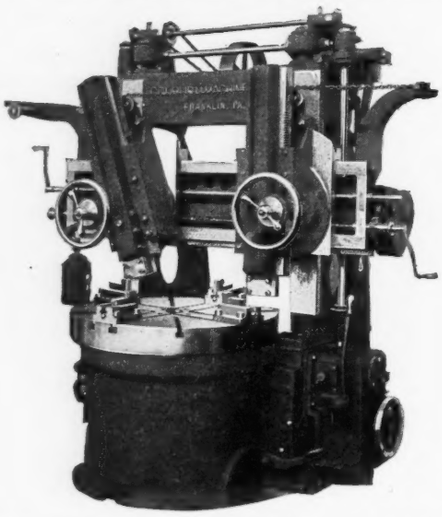
Write for our Bulletins Nos. 3056-D and 3065-D *today*. We can convince you.

Line of Turret Lathes operated by Individual Western Electric Motors

WESTERN ELECTRIC COMPANY

CHICAGO NEW YORK PHILADELPHIA PITTSBURG
CINCINNATI ST. LOUIS ST.PAUL KANSAS CITY
DENVER LOS ANGELES SAN FRANCISCO
ATLANTA SEATTLE

COLBURN
BORING MILLS



More Work and Better Work

CAN BE COUNTED ON FROM

Colburn Boring and Turning Mills

than any other make because they are rigid, strong, have the power for high speed steels; are accurate and very rapid in operation. Sizes from 34″ to 72″. *Write us.*

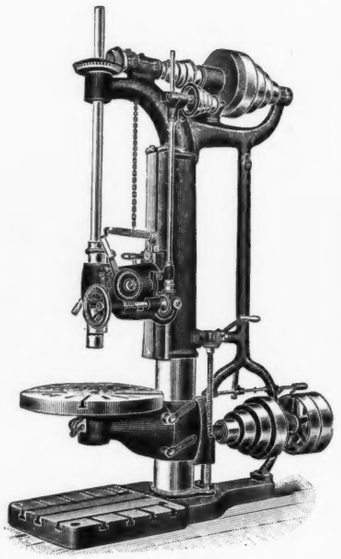
Colburn Machine Tool Co., Franklin, Pa.

Foreign Agents: Ludw. Loewe & Co., Berlin and London.

OUR LINE

32-in.
26-in.
24-in.
20-in.
14-in.
14-in. B
13-in. B
Standard Drills

No. 1
No. 2
Friction Drills



32-in. Drill

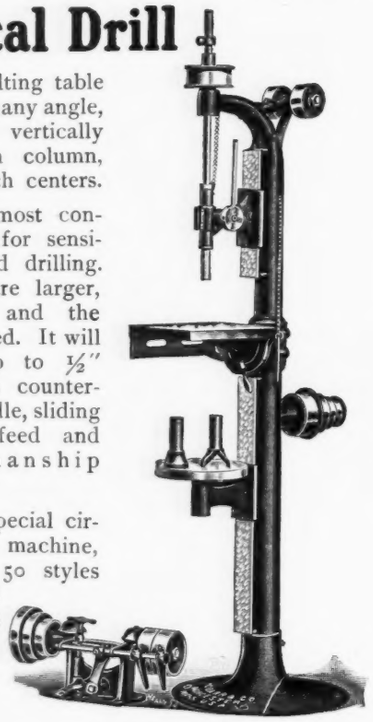
Mechanics Machine Co.,
Wyman and Mill Sts.,
ROCKFORD, ILLINOIS, U. S. A.

No. 4 Fourteen Inch Vertical Drill

with square tilting table for drilling at any angle, round table, vertically adjustable on column, cup and crotch centers.

One of the most convenient tools for sensitive and rapid drilling. The pulleys are larger, belts longer and the power increased. It will drill holes up to ½″ diameter, has counterbalanced spindle, sliding head, lever feed and finest workmanship throughout.

Write for special circular of this machine, one of over 50 styles Single and Multiple Drills manufactured by



H. G. BARR, Worcester, Mass.

The All Embracing Dill

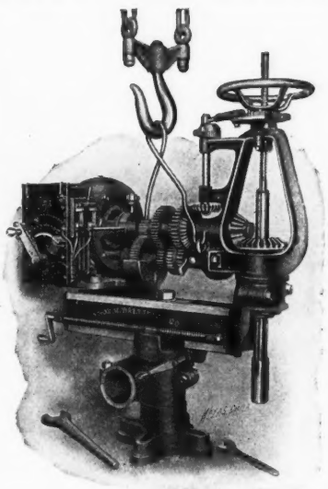
The range of work an ordinary size **Dill Slotter** will cover is a matter of amazement to a person unacquainted with the special features of this machine.

But a little consideration of the traveling head, quick traverse gear, new quick return, automatic knock-off, hand wheel controllor, new intermittent feed, and other exclusive Dill points, soon shows the reason and explains why it is the most economical tool of its class you can have in your shop.

Send for Catalogue

The Dill Slotter People, Philadelphia, Pa.

"Dallett" Motor-Driven Portable Drills



The Handiest Tools for any Shop

Our No. 1 MOTOR-DRIVEN, just out, has a capacity of 1 inch in steel and weighs only 225 lbs.

Write for New Bulletins.

Thos. H. Dallett Co.
23d and York Sts., PHILADELPHIA, PA.

WALTHAM MACHINE U.S.A. WALTHAM MASS. WORKS

OUR LINE OF WORK:

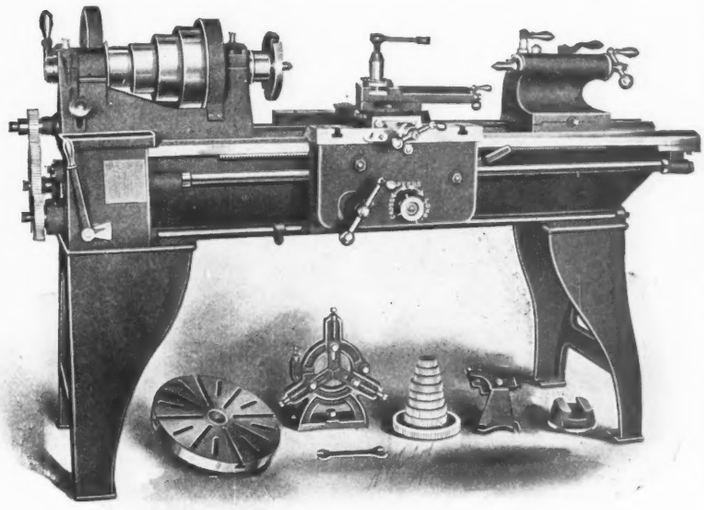
Automatic Pinion and Gear Cutting Machines
Machines for Watch and Clock Factories
Machinists' Bench Lathes
Sub Press Dies
Designing and Building Special Machines

NEW DESIGNS. BEST QUALITY.

LATHES, PLANERS, SHAPERS, MILLERS
TOOLS
FREVERT MACHINERY CO
NEW YORK
DRILLS, GRINDERS, CRANES & TROLLEYS
18 DEY ST. 18 DEY ST.

Standard Engine Lathes

12-inch, 14-inch and 16-inch Swing



This 14-inch x 6-foot Engine Lathe

is an example of our line of Standard Engine Lathes—powerful, heavy and rigid machines, built on good common-sense lines and adapted to stand hard, everyday service. The 14 in. x 6 ft. machine weighs 1630 pounds, is fitted with every convenience and has proved itself rapid, accurate and durable. **Catalogue "B" gives all the details.**

We also build the 9" and 11" Star Lathe, Speed Lathes, Bench Lathes, Wood Turning Lathes and a line of Foot Power Lathes.

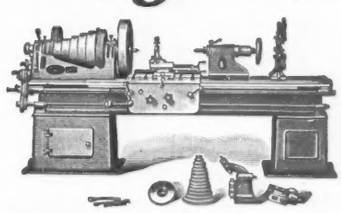
The Seneca Falls Mfg. Co.

330 Water Street, Seneca Falls, N. Y. (127

New Haven Mfg. Co.

Manufacturers of

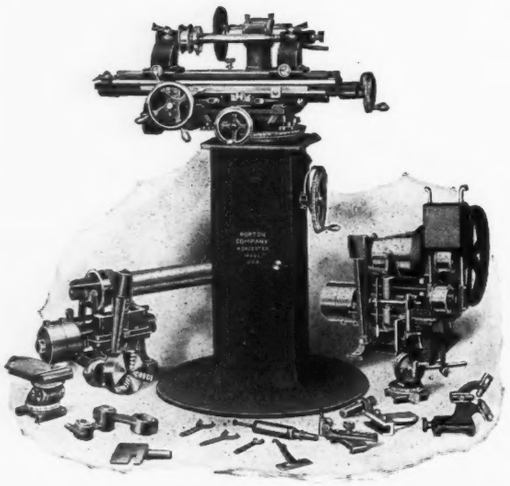
Slotters, Planers, Lathes, Drills, Etc.



NEW HAVEN, CONN., U. S. A.

NORTON UNIVERSAL TOOL AND CUTTER GRINDER

Specially Adapted for Tool Work



Provided with attachments that are easily adjusted for the various operations of grinding Milling Cutters, Reamers, Counterbores, Taps, End Mills, Holes, Arbors, etc., and for surface grinding.

Made in two sizes.

Send for Catalog T. C. which gives full details.

NORTON GRINDING COMPANY

Main Works, Worcester, Mass., U. S. A.

Chicago Store, 48 So. Canal Street

T. C. 2

ABRASIVE GRINDING WHEELS

make friends wherever introduced, because of their excellent qualities, such as cool cutting, extreme durability, perfect safety and uniformity.

Another factor of their success is due to our policy of selecting from our great assortment, just the right wheel for the purchaser's needs. Twenty years' experience has taught us how to do it, and you get the benefit of this experience without extra charge. Tell us about your work and let us send you a trial wheel.

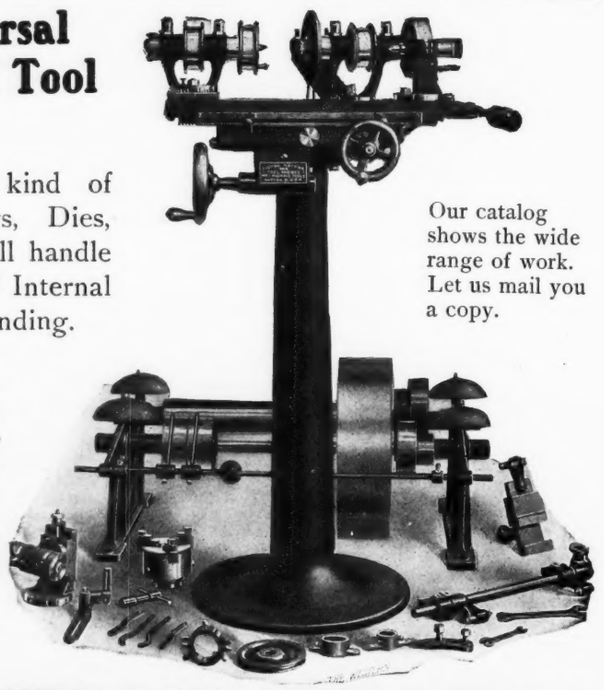
ABRASIVE MATERIAL CO.

PHILADELPHIA, PA.

H. A. Stocker Machinery Co., Chicago, Ill.

The Universal Cutter and Tool Grinder

Grinds every kind of Cutter, Reamers, Dies, Chasers, and will handle a wide range of Internal and Surface Grinding.



Our catalog shows the wide range of work. Let us mail you a copy.

A special advantage of this machine is the accuracy of work turned out, and the ease with which adjustments can be made. Rigidity is another strong point. All working parts are protected from dust and dirt.

DAYTON MACHINE & TOOL WORKS, DAYTON, O.

STAR CORUNDUM WHEEL CO.

DETROIT, MICH., U. S. A.

VITRIFIED, SILICATE AND ELASTIC CORUNDUM AND EMERY WHEELS.

ROUND HOLES AT A MINIMUM COST

One of the difficulties that confront the automobile and gas engine manufacturer is how to obtain a round, straight, smooth bore in the cylinder at a reasonable cost.

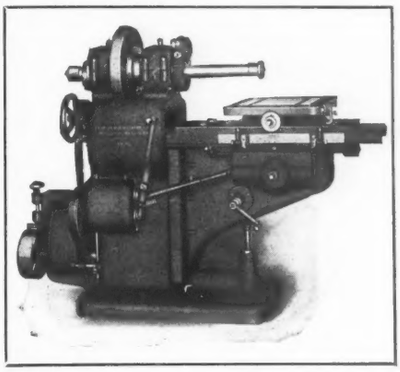
THE HEALD CYLINDER GRINDER

Solves the problem on every point—is especially designed to do accurate internal grinding in a special way, and has unusual features that permit rapid handling, overcome the every-day difficulties of such work and reduce the cost to the lowest limit.

It is also a valuable tool for the machine tool builder, as the work not being revolved, holes can be finished in castings of any shape.

We shall be glad to forward our Treatise on Internal Grinding if you are interested.

THE HEALD MACHINE COMPANY
147 BOND STREET WORCESTER, MASS.



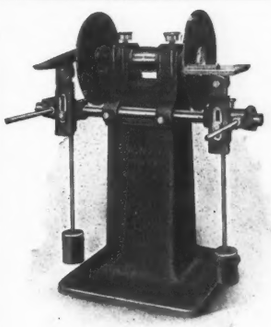
VITRIFIED CORUNDUM WHEELS

THE COOLEST CUTTING WHEELS

on the market and the most satisfactory on every other count. Made from almost pure corundum, by the vitrified process, they are 50 per cent. more efficient than other abrasive wheels, cut faster and cleaner, will not glaze and never draw the temper of the tool being ground.

Sent on trial when desired.

The Vitrified Wheel Company
WESTFIELD, MASS.



STOP, LOOK, LISTEN—

"OUR GUARANTEE"

The Ney Disk Grinder is the equal of any made, in Cutting Speed. We do not "guarantee" this only, but we *state* it and it's *a fact.*

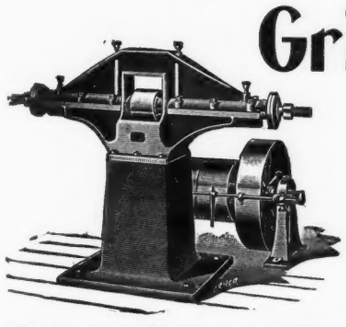
The *ordinary* loose guarantee simply means that if a machine doesn't fulfill the maker's claims you can return it—and try someone else. Now, where do you come in on that?

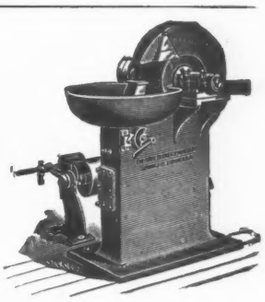
"OUR" guarantee means that if our machines are not as represented we will send you one that *is* right. Our first complaint is yet to arrive.

PRECISION DISK GRINDERS

ROSCOE W. NEY, Kingston, N.Y.

Emery Wheels and Grinding Machinery





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Foreign Agents:
Pfeil & Co., London.
F. Lowener, Copenhagen, Stockholm.
Adler & Eisenchitz, Milan, Italy.
Defries & Co., Act. Ges., Berlin, Dusseldorf.

THE SAFETY EMERY WHEEL COMPANY, Springfield, Ohio, U. S. A.

Why not use the abrasive wheel best suited to your work?

Sterling Emery and Corundum Wheels

Are made in every grade from the finest to the coarsest.

SAFE RAPID EFFICIENT

Write for Catalogue.

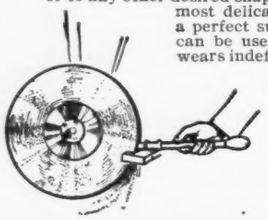
STERLING EMERY WHEEL MFG. CO.

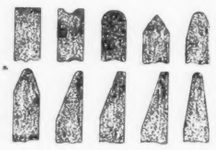
Factories and Offices, TIFFIN, OHIO

BRANCHES: New York House, 45 Vesey St. Chicago House, 30-32 So. Canal St. San Francisco House, 21-23 Fremont St.

With a DIAMO-CARBO EMERY WHEEL DRESSER

Grinding wheels can be shaped to any of the forms shown, or to any other desired shape, without danger of injuring the most delicate edges. The Diamo-Carbo is a perfect substitute for the black diamond, can be used with all tool grinding wheels, wears indefinitely, cannot get lost or broken and is one of the successful tool-room economies.



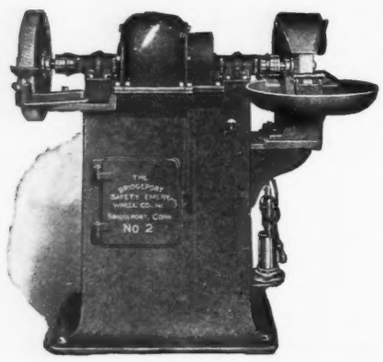


Made in three lengths: 8", 10" and 12" respectively.

Prices $3.00, $3.50 and $4.00

Let us send a Dresser on ten days' trial. Booklet and testimonials for the asking.

Desmond-Stephan Manufacturing Company, Urbana, Ohio



DRY GRINDER one end, IMPROVED TOOL GRINDER the other.

Thoroughly practical, saves space, saves money.

Further details by mail.

The Bridgeport Safety Emery Wheel Co., Inc.,
BRIDGEPORT, CONN., U. S. A.

Emery Wheel Dressers and Cutters

Cutters uniformly tempered. Made of the best Tool Steel and not stamped but milled.

GEORGE H. CALDER, - LANCASTER, PA.

The Sherman Emery Wheel Dresser

THE BEST MECHANICAL DRESSER MADE

CORRUGATIONS

Pat. Nov. 24, 1903. Apr. 10, 1906.

Sent on fifteen day's trial. Write for circular.

Cuts faster and lasts longer than any other on the market. All wearing parts are hardened. Cutters made of tool steel tempered and always remain sharp as the corrugated face remains the same until worn out.

Price $1.50 with extra set of cutters. Cutters 15 cts. set; Per. doz. sets, $1.50

Sherman Manufacturing Co., St. Paul and Cadillac Sts. DETROIT, MICH., U.S.A.

HAVE ONE AT HOME

THIS GRINDSTONE is admirably adapted for grinding small tools used by mechanics, jewelers, etc., as well as for household or hotel purposes.

The frame is strong and well made.

The stone, 14 in. x 1¾ in., is carefully selected of the proper grit to do the work intended.

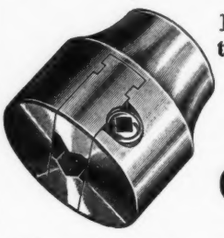
Weight, 60 lbs.

Price, $4.50.

Send for new catalog of Vises, Grindstone Frames, Mechanics' Tools, etc.

Athol Machine Co.,
ALTHOL, MASS., U. S. A.

No Weak Places



In the Reid Drill Chuck.

One part is as strong as another. Outwears any other kind of chuck. Made right and sold at the right price. Circulars and price list mailed on request.

R. H. BROWN & CO.
New Haven, Conn.

Nine Times out of Ten

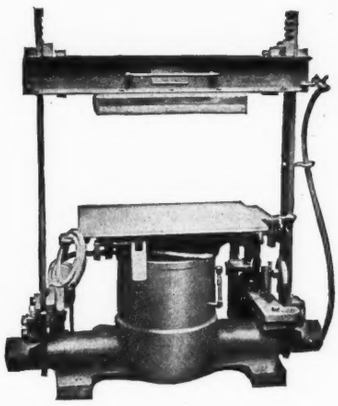
Made in sets of nine and will fit any sized hole from one to seven inches. Catalogue for full particulars.

The time required for a man to hunt through a pile of solid mandrels for one just the right size for the job in hand, would be sufficient to get the work half done with **Nicholson's Expanding Mandrels.** Isn't this worth investigating? Nicholson's Mandrels are strong, durable, compact and convenient. All parts interchangeable.

W. H. Nicholson & Co., Wilkes-Barre, Pa., U.S.A.

FOREIGN HOUSES—C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Cologne, Vienna, Brussels, Stockholm, St Petersburg.

Tabor Molding Machines.



Cut shows 13″ Cylinder Power Squeezer designed to squeeze the sand to the proper density instead of ramming by a blow.

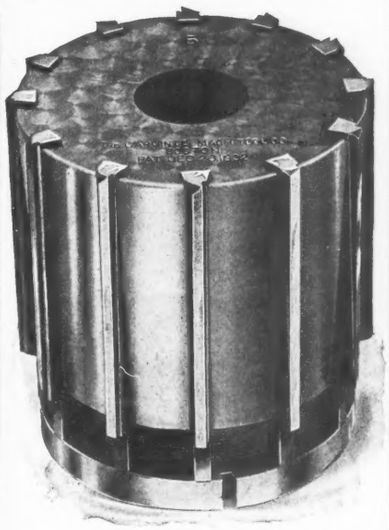
Machine is adapted for use with Vibrator Frame, Paraffine Board or Plated Pattern.

Write for Catalogue.

The Tabor Manufacturing Co.,

18th and Hamilton Streets

PHILADELPHIA, PENNSYLVANIA



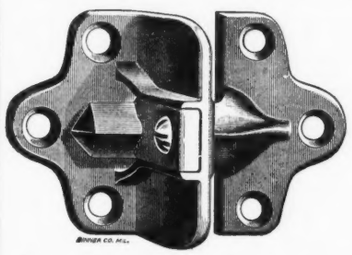
5" ADJUSTABLE REAMER

We make them to all sizes from 1″ to 8″ or larger, shell, solid shank and hand Reamer style.

THE LAPOINTE MACHINE TOOL CO.

HUDSON, MASS.

Pattern Makers' Specialties



Frazer's Adjustable Malleable Iron Flask Pin

saves time, expense, and makes true castings. Quickly applied and easily adjusted.

Leather Fillet Cutter

One of the handiest tools for the pattern maker, a double ended reversible knife that will cut Fillets any size or shape required.

Send for Price List on Our Line of Specialties

Milwaukee Foundry Supply Co., Milwaukee, Wis.

Foundry Material

FACINGS AND PLUMBAGO

Everything from a Molding Tool to Cupola

Our Catalog describes everything

J. W. PAXSON CO.

Philadelphia, Pa.

"CINCINNATI" PUNCHES

THE CINCINNATI PUNCH & SHEAR CO., Cincinnati, Ohio

COMPLETE INDEX TO

Machinery's Data Sheets

SENT ON REQUEST.

Stop

just long enough to say yes or no to a Williams query.

Are you using the right sorts of Wrenches in their places or are you forgetting the "get there" wedges?

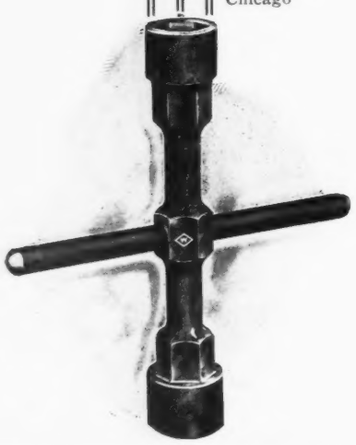
We know you're busy.

Have you time to look over Book "B"

J. H. Williams & Co.

Superior Drop-forgings

Brooklyn
Chicago



The Shop Operation Sheets

This series began with the May issue. Begin your subscription with that number.

MACHINERY, - ALL EDITIONS.

A Franklin Finished Casting

Represents time gained, money saved, accuracy preserved and a lot of fuss and bother entirely eliminated Cuts out all the machine work—each piece is die cast and comes to you *finished* ready for assembling. There is no chance for differences, every piece is a facsimile of the other. Do you see the advantage for small duplicate parts?

Glad to mail catalogue with full particulars.

Franklin Mfg. Co., 203 So. Geddes St. SYRACUSE, N. Y.

"Economo" Emery Wheel Dressers

Length 12 In.

Shorter lengths on application.

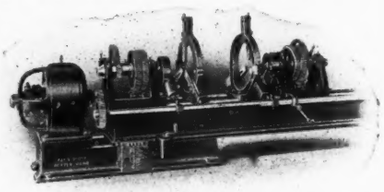
"COMBINATION"

Made of an abrasive nearly as hard as the black diamond. Will true and shape any wheels except the very hard and carborundum. The "Combination" Dresser is the roughing dresser placed in the "handle end" of the "Economo". The cutters of the "Combination" are made of "Crucible" steel and excel in wear and efficiency any dresser heretofore made.

Sent on fifteen days' trial. Write for circular.

INTERNATIONAL SPECIALTY CO., 363 Holden Ave., Detroit, Mich

32" DOUBLE HEAD FACING MACHINE



This machine is designed to be used for facing the flanges of pipes, pipe fittings and similar work, held in stationary fixtures on the bed. *Ask for circular.*

Fay & Scott, Dexter, Me., U.S.A.

THE BLACKSMITH'S GUIDE

By J. F. SALLOWS

Over One Hundred and Fifty Illustrations

Price, $1.50

A Book that Tells How by a Man Who Knows How

Tells how to do machine forging; weld iron and steel; weld a ring true to size; forge, harden and temper lathe, planer and hand tools; harden cutters, taps, dies, punches, broaches, etc.; treat high-speed steel; anneal steel; case-harden; pack-harden; mottle and color steel; braze; bend pipe; straighten sheet steel; and do general blacksmithing.

Contains full directions for making an oven for hardening and tempering; for making a brazing furnace; and a special forge for high-speed steel. Complete working drawings for a furnace that can be built at small expense for case-hardening and coloring metals; two color charts as guides in hardening and tempering; and a colored plate showing the beautiful results in coloring obtained by Mr. Sallows by methods explained in his book.

If YOU want to know how, get this latest handbook on the treatment of steel.

Sent on approval to any reader of MACHINERY.

The Technical Press, Brattleboro, Vt.

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SHAPERS

EXCLUSIVELY.

12 TO 32 INCH STROKE.

SMITH & MILLS,
Cincinnati, Ohio, U. S. A.

Two year courses in
Steam and Machine Design
Applied Electricity
Applied Chemistry
One year course in
Machine Construction

Write for catalog and particulars

PRATT INSTITUTE, Brooklyn, N. Y.

Vertical Miller and Slotter

Two Sizes

Slotter always ready to use and never in the way of milling.
It will cut out those square corners quicker than any other machine. Prompt delivery.

Full particulars and prices sent on request.

R. M. CLOUGH,
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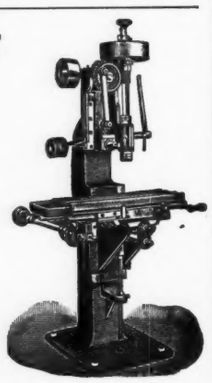

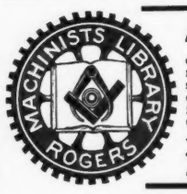

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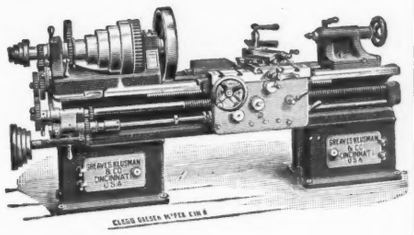

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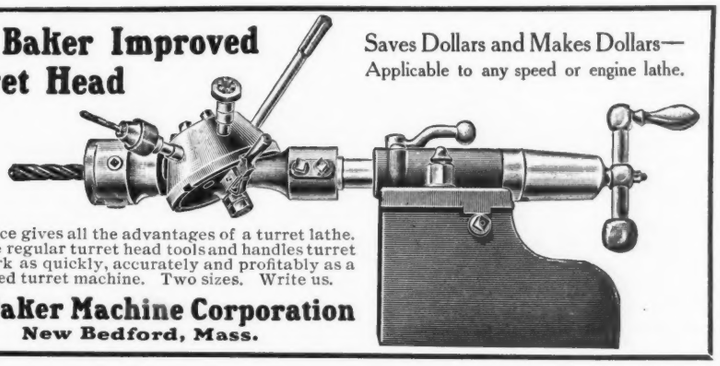

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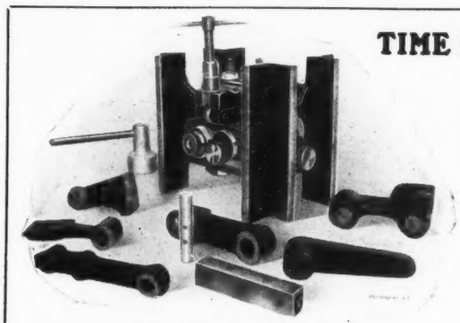

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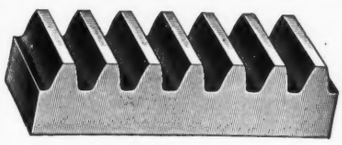

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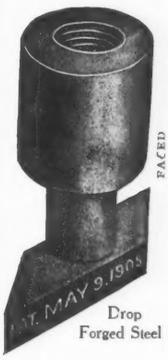

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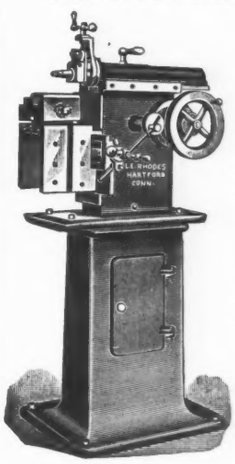

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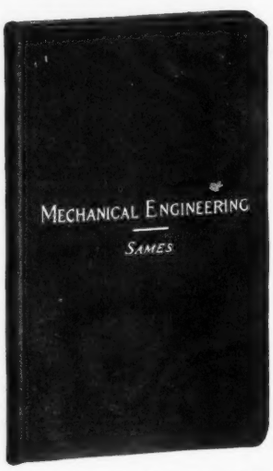

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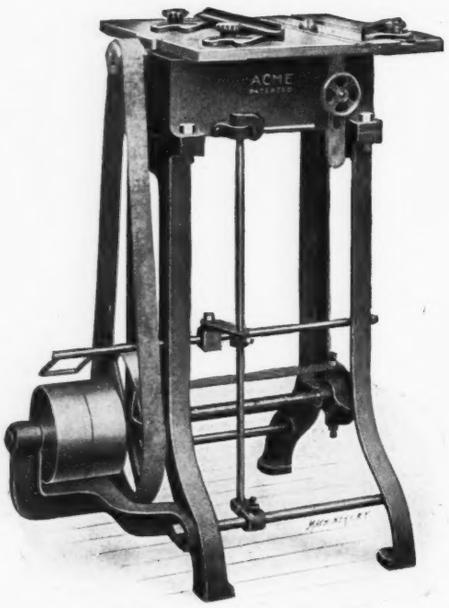

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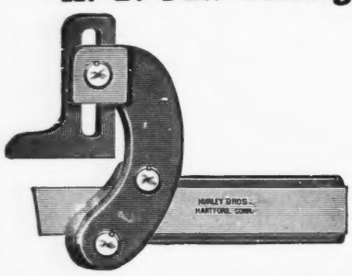

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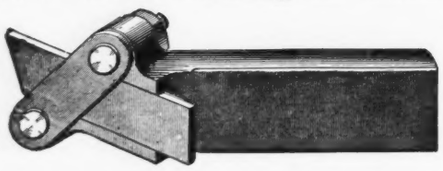

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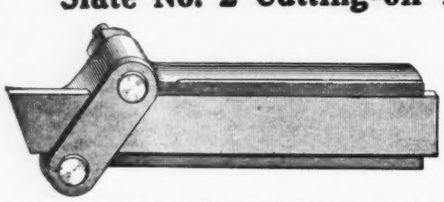

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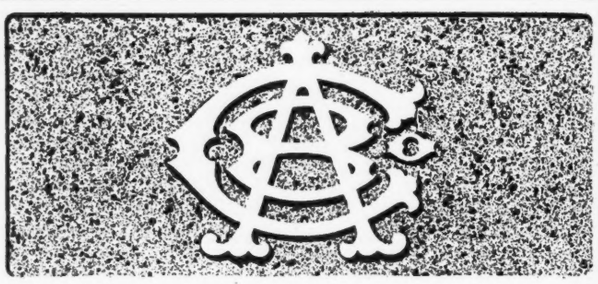

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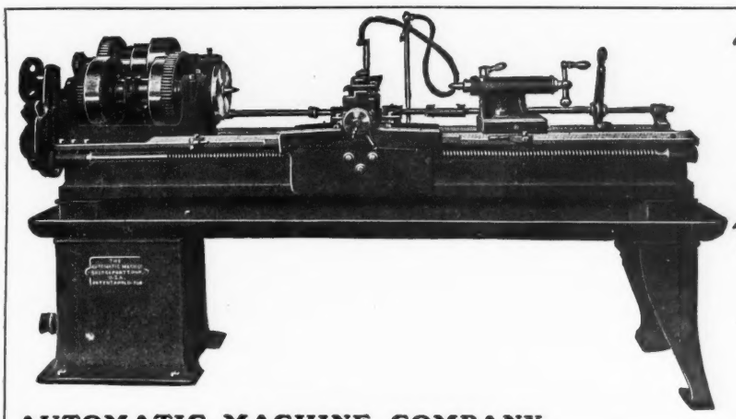

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of all kinds, internal or external—screws, worms, nuts—right or left hand threads, straight or taper, can be accomplished with the

AUTOMATIC THREADING LATHE

more rapidly, with greater ease and with greater economy than by any other method. Does not require special tools. Entirely automatic in operation, so one man can look after several machines.

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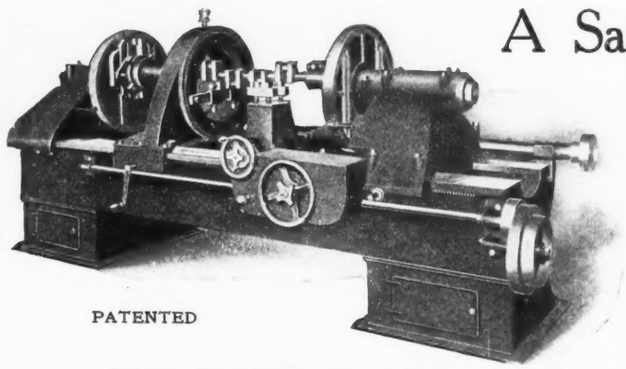

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is assured with the Tindel-Albrecht Crank Shaft Lathe. This is a heavy, rigid machine with particularly powerful drive and special features that put it ahead of any other machine for rapidly reducing rough crank shaft forgings to grinding sizes.

Uniform drive from end to end. Write us about it.

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14-inch Engine Lathe

An up-to-date machine, new design, extra large ground spindle, wide face gearing, T-slots in carriage, rapid feed changes, wide belt. It is provided with an Index Dial for catching threads quickly, has automatic stop in either direction, and cuts threads from 2 to 96.

For other special features see our circular.

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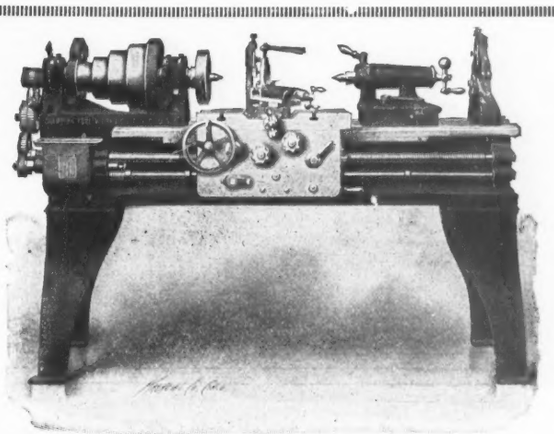

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We can furnish metal gears of any metal required, in bevel gears up to 48 in., in spur gears to 36 in., with the teeth accurately planed and spur gears to 60 in. cut with rotary cutter. Let us submit estimates on your requirements in this line. Our workmanship is unexcelled and our prices are right for high grade work.

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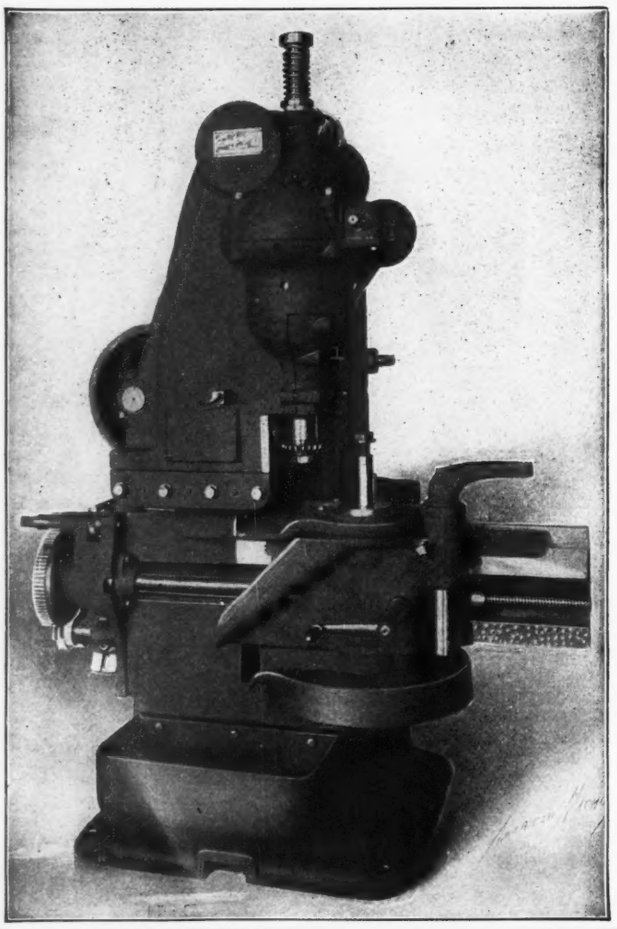

"BEFORE CLOSING I CANNOT RESIST SAYING THAT I HONESTLY BELIEVE YOUR GEAR SHAPER IS THE GREATEST MACHINE FOR CUTTING ACCURATE GEARS EVER BUILT AND IT ACTUALLY EATS THEM UP." *—A Satisfied User.*

We wish to talk over with you the matter of rapid gear cutting, and to tell you exactly how fast the Gear Shaper would "eat them up" in your own shop. This machine is 25 to 50 per cent. faster than any other gear cutter on the market, and it also cuts smoother running gears than any competing machine.

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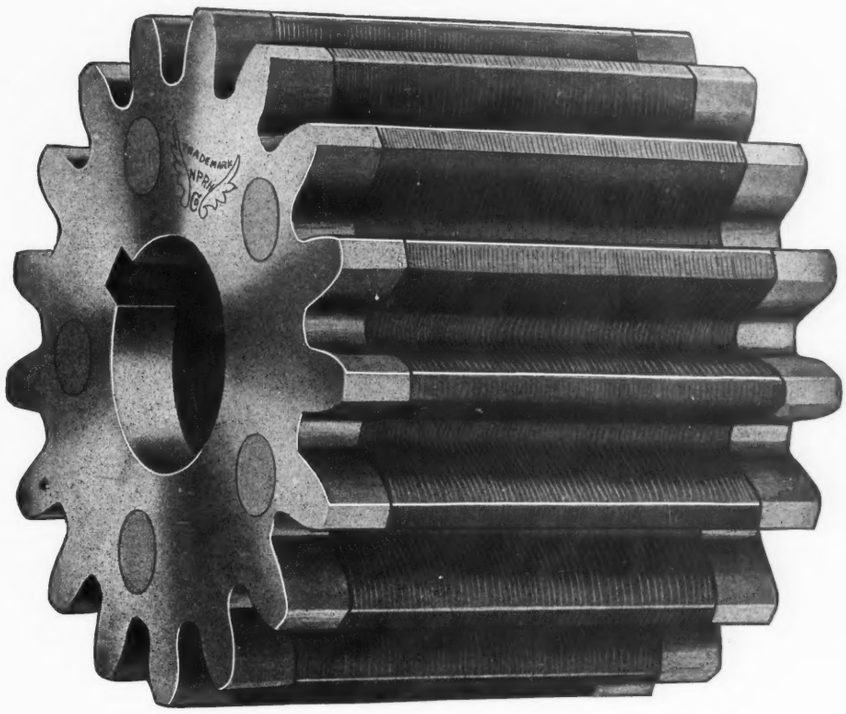

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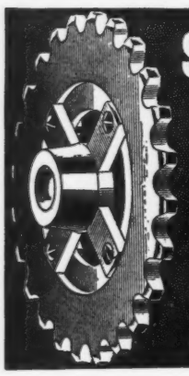

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Bevel Gears,
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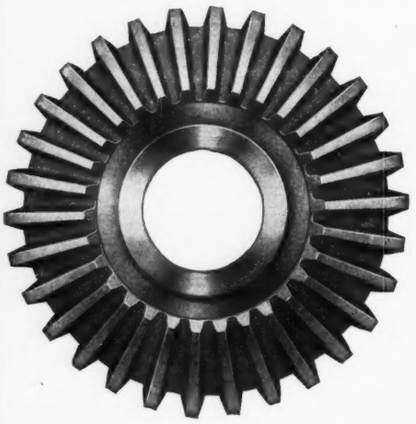
Worms and Worm Wheels and Bevels to 6 ft. and Spur Gears to 7 ft. in dia.



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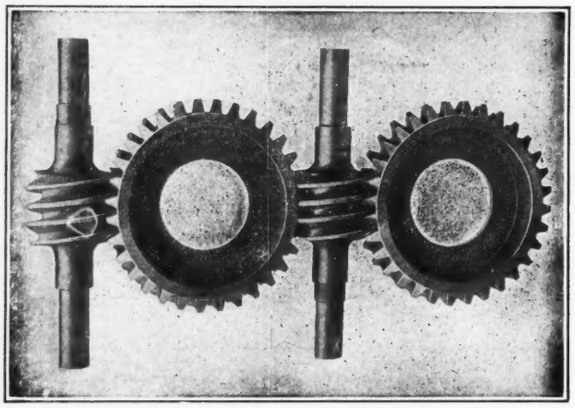

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is demonstrating its ability to stand the requirements of the mining engineer in designing machinery using transmission gears for high power and heavy service.

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Engineers **PHILADELPHIA, PA.**

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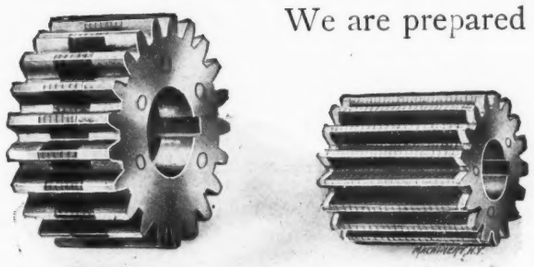

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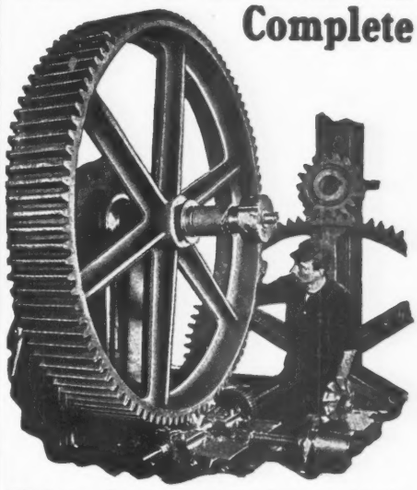

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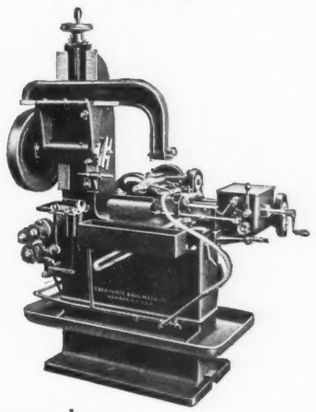
EBERHARDT BROTHERS
AUTOMATIC GEAR CUTTING MACHINES
(PATENTED)



Eberhardt Brothers Patented Automatic Gear Cutting Machines embody a **positive indexing mechanism,** which insures accurately cut gears; a **Draw-cut Feed-screw** and efficient cutter-driving mechanism, which insure rapid production and smoothly cut gears.

The operation is **entirely automatic** and **positive** in action. We build all sizes, covering practically all classes of work.

THE DESIGN AND MANUFACTURE OF AUTOMATIC GEAR CUTTING MACHINES IS OUR EXCLUSIVE SPECIALTY.

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GEAR SPECIALISTS
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Quality,
Workmanship,
Design

all the best and bound to suit the most skeptical buyer.

We excel in GEAR CUTTING.

Special attention given to Break-down Jobs.

—Write us.—

The Van Dorn & Dutton Co.,
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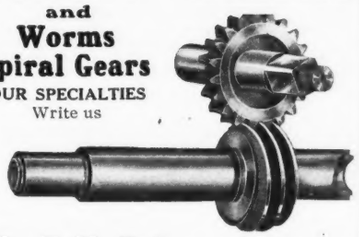
WORM GEARS
and
Worms
Spiral Gears
OUR SPECIALTIES
Write us



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Successors to this dept. of the SCHACHT MFG. CO.

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We are the acknowledged leaders in Clothes Locker manufacture. Our equipment has enabled us to out-distance competition as to price, delivery and quality.

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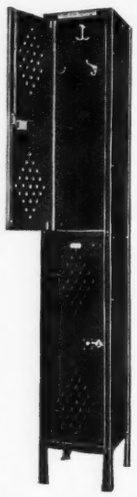

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Send for Catalogue **and Price List**

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The Service in Any Shop

will be quicker and better if this

All Metal Truck

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No wasted oil, soiled hands or clothing with the

Delphos Non-Overfilling Factory Dispenser

because as soon as the receptacle is filled the overflow is siphoned back into the can by means of the double-tube spout. The Delphos is adapted for filling all styles of metal oilers, especially hand oilers, and pumps any kind of machine oil. It is strong, durable convenient, works quickly and easily and can be carried from place to place.

Galvanized iron, 3, 5 and 10 gal. sizes.
Let us tell you more about it.

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Our system of Tool Holders is used exclusively in many of the largest shops in the country, **WHY?** Because they Get Results. They have good cost-systems and **KNOW.**

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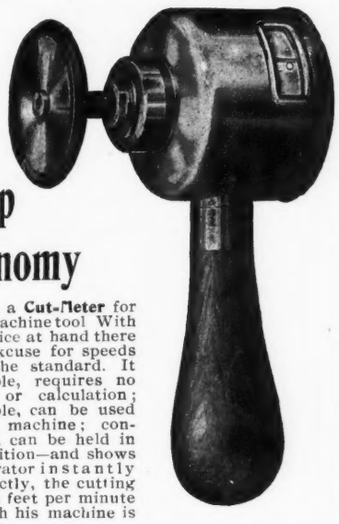
It Is Shop Economy



to have a **Cut-Meter** for every machine tool With this device at hand there is no excuse for speeds below the standard. It is simple, requires no timing or calculation; adaptable, can be used on any machine; convenient, can be held in any position—and shows the operator instantly and exactly, the cutting speed in feet per minute at which his machine is running.

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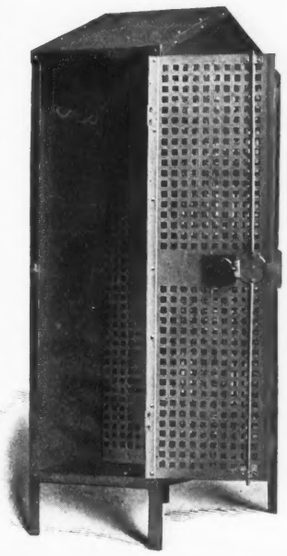
You'll Find Hart & Cooley Lockers



in shops and factories where modern methods prevail, because the H. & C. Locker is essentially up-to-date. They are built on the unit system, adaptable to any space; material is wrought steel perforated stock— smooth, finely finished, easily cleaned. Hooks, shelves, locking devices are of the most approved order. Full line of sizes. There are other good-locker points made plain in our Catalogue "C"—may we send a copy?

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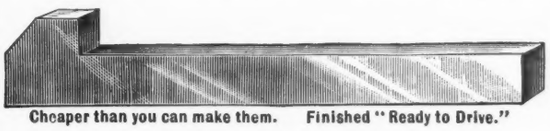
"NOISELESS"

Bantam Anti-Friction Co.
Bantam, Conn.

Finished Machine Keys



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All sizes carried in stock.
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¼ in. Shaft and up. No fitting, just push them on. 10 cts in stamps for sample.

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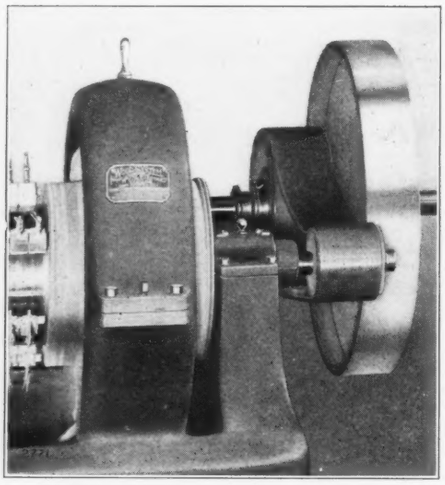

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Supersedes Other Forms of Power-Transmission

because its action is positive, smooth and quiet. Will run in either direction on long or short centers. Its field of application is almost universal. Ask us for proof.

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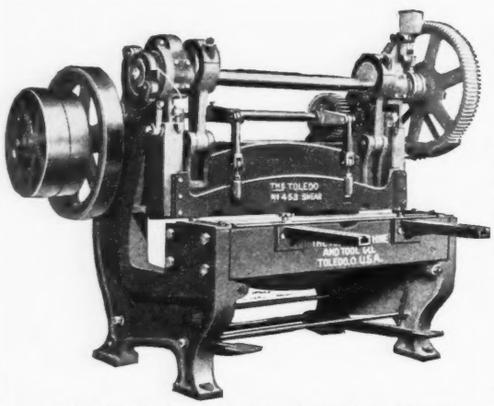

"Toledo" 60 inch Double Geared Gap Shear No. 453.

"You Want the Best—Buy of Us."

"Toledo" Shears

Are *guaranteed* to *successfully stand up continuously* on *maximum work* of *listed capacity.*

No. 453 has a capacity for plate 3-16 inch thick and lighter. Fitted with cam actuated automatic clamping or hold-down attachment. Gears are machine cut from the solid. Clutch is of the well known "Toledo" three engagement sliding block type with patented gravity releasing or controling device.

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A cement adapted for use with iron or steel castings; fills cracks, blow holes or other imperfections. It adheres to the iron, is the same color and becomes practically a part of the casting itself. Expands and contracts with the metal and makes joints steam, water, gas or air-tight.

Indispensable for foundries, engineers, etc.

Sample sent on request.

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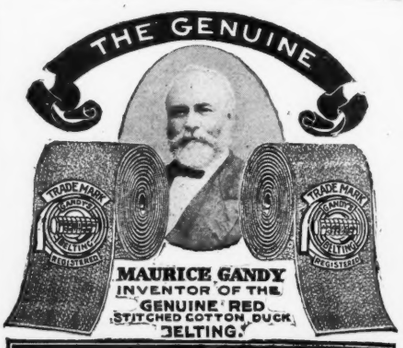

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AS A BUSINESS PROPOSITION

the Gandy Stitched Cotton Duck Belt is the best yet. Why? Because it gives better satisfaction under all conditions than others, lasts several times longer than others, and costs only one-fourth as much as a leather belt. Strong claims? Yes, but we can make them good. Send for booklet—"*Experiences with Gandy*" and see what others say. In buying, look for the right trade mark—coil of belt, bale of cotton and name.

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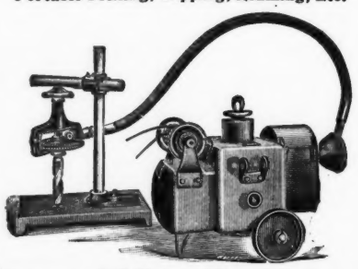
Combination of

Stow Flexible Shaft and Multi-Speed Electric Motor.

Portable Drilling, Tapping, Reaming, Etc.



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Selig, Sonnenthal & Co., General European Agents, London, Eng.

It Pays to use and It Pays to sell

Our 6-inch Double Jaw Caliper

Catalog shows many other styles.

Our clubbing proposition will interest you.

E. G. Smith Company
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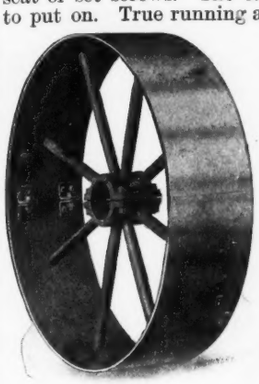
The "Latshaw" All Steel Split Pulley.

Built to do the work of a double belt cast iron pulley and without the use of key-seat or set screws. The easiest pulley to put on. True running at all speeds.



They are simple in design. Similar to cast iron in appearance, made without **Rivets** at arm fastenings in hub and rim.

"Last but not least, prices are satisfactory."

Eightarm construction, used on pulleys from 30" to 50" inclusive, 4" to 12" width of face inclusive.

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Boston Stock: Brown, Wales & Co. Chicago Stock: R. R. Street & Co. New York Stock: Henry J. McCoy Co.

THE SCHWERDTLE STAMP CO.,
STENCILS-BURNING BRANDS
STEEL STAMPS & DIES
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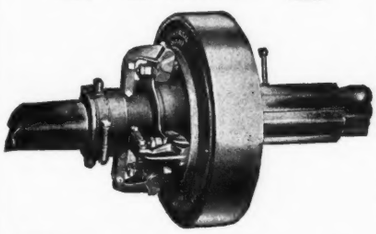
UNIVERSAL GIANT



Friction Clutch

No Special Pulleys are needed with this Clutch, any ordinary pulley, solid or split can be used, saving expense and bother. It is strong, compact, easily adjusted, will run at any speed and is the Clutch for modern conditions.

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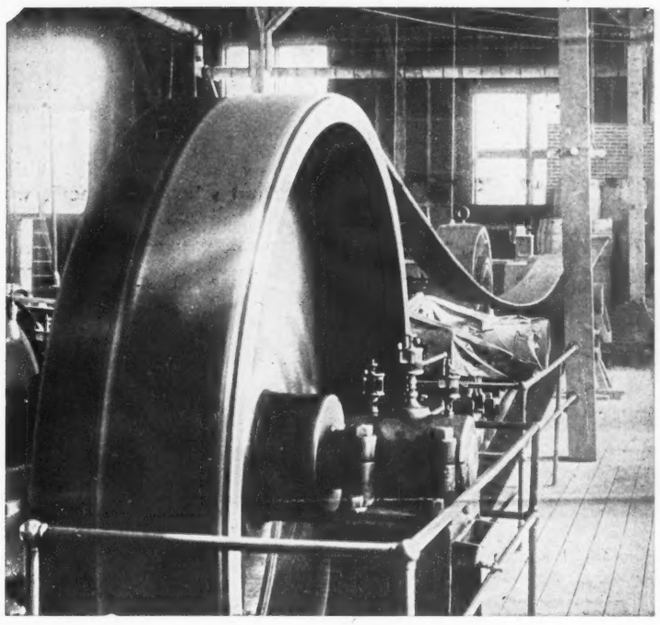
Chambersburg, Pa.

Mfrs. of Shafting, Pulleys, Hangers, Couplings, etc.



Old or Oily Belts

Don't throw these away.

Treat them with Cling-Surface and make them new again.

This belt was old, full of oil and dirt (we took 30 lbs. off it) when put on.

It was very tight and wouldn't half work.

We scraped it, treated and slacked it up and it was doing 140 H.P. when photographed and doing it easily.

The oil was coming through the back in drops—pushed out by the Cling-Surface.

You can take any belt you have, new or old, dry or oily, use Cling-Surface and run it slack, no matter what its position, and pull fullest loads.

We guarantee it. Try Cling-Surface and see.

Write us. We have a mighty interesting matter for you.

CLING-SURFACE CO 1018 Niagara St Buffalo N Y

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ATLAS EXTRACTOR OF BROKEN TAPS

A strong and simple device for removing taps broken off in a tapped hole. Saves its cost in the time saved removing the first broken tap.

Send for catalogue and price list.

ATLAS MACHINE COMPANY, - PROVIDENCE, R. I.

Also Makers of the Atlas Swivel Vise and Atlas Tool Makers' Vise.

The
AMERICAN
WROUGHT STEEL SPLIT PULLEY

For all around service.
All dealers carry these pulleys.

Patented in the United States and Foreign Countries.

Lighter in Weight and Stronger than other Pulleys.

Save power and are safe under the highest speeds.

Booklet sent on request.

The American Pulley Co.
29th and Bristol Sts., PHILADELPHIA, PA.

Bradley Compact Hammer.

If your forging is of a general, all around jobbing character with frequent variations in the size of stock, or

If it is of such a nature that the hammer is not working continuously, but with frequent stops, or

If your floor space is limited but with good height, a Bradley Compact Hammer would prove a money maker.

It is compact in design, occupies but little space and can be run at high speed.

As it weighs considerably less than our regular Upright Hammer its price is much less.

Made with head weighing 15 to 200 pounds.

WE MAKE....
The Bradley Cushioned Helve Hammer.
The Bradley Upright Strap Hammer.
The Bradley Upright Helve Hammer.
The Bradley Compact Hammer.
Forges for Hard Coal or Coke.

SEND FOR CIRCULARS

C. C. Bradley & Son, Syracuse, N. Y.

FOREIGN AGENTS: Schuchardt & Schütte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schütte, Cologne, Brussels, Liège, Paris, Milan, Bilbao. Buck & Hickman, Whitechapel Road, London.

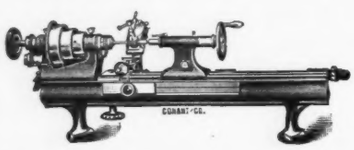
THE BEAUDRY Champion Power Hammer

Simple, Durable, Efficient and Economical.
Adapted for Every Description of Forging.
Should be in Every Blacksmith Shop.

Send for Circular.

BEAUDRY & CO., Inc.
141 Milk Street BOSTON, MASS.

Engineers, Electricians, Tool-Makers, Model-Makers



and workers in other lines where extreme accuracy is essential will find that

Stark Precision Lathes

meet their requirements exactly.

Let us send you catalogue B.

STARK TOOL COMPANY, Waltham, Mass., U. S. A.

ELECTROTYPERS

All kinds of plates for printing

THE LOVEJOY CO., Established 1853, **444-446 Pearl St., New York**

Scranton Power Hammers

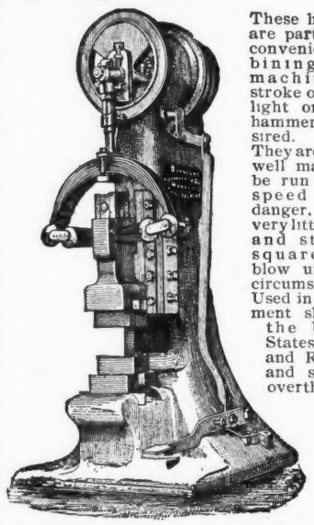
COST LESS than any other hammer that will produce an EQUAL AMOUNT OF WORK.

By our construction we avoid breakdowns.

Send for Circular 37.

The Scranton & Co. New Haven, Conn.

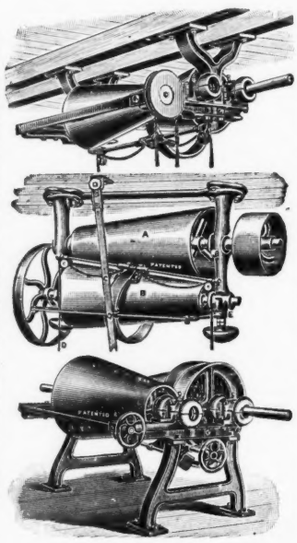
Spring Power Hammers



These hammers are particularly convenient combining in one machine the stroke of a very light or heavy hammer as desired.
They are strong, well made, can be run at high speed without danger, require very little power and strike a square, true blow under all circumstances.
Used in government shops by the United States, France and Russia, and sold all over the world.

DIENELT & EISENHARDT, Inc.
1304 No. Howard Street
PHILADELPHIA, PA., U. S. A.

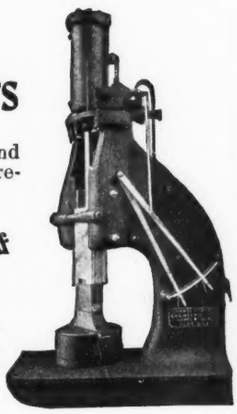
Evans Friction Cone Pulleys
VARIABLE SPEED COUNTERSHAFTS



Will drive your machine at any desired speed from 1 to 6. Over ten thousand sets in operation in this country and Europe. **Send for catalogue.**

G. F. Evans, Newton Center, Mass.

Steam Hammers



In all sizes and for every requirement.

Single Frame & Double Frame

Most complete and extensive equipment for their manufacture.

Largest and most modern line of patterns.

Also STEAM DROP HAMMERS
in all sizes up to 12000 lbs.
Falling weight.

CHAMBERSBURG ENGINEERING CO.
Chambersburg, Pa., U.S.A.

We Don't Boast

When we assert that **Leviathan Belting** will show up better than any other belt under any condition.

Twenty-five years of manufacturing this scientifically constructed belt, has proved so conclusively.

Write for sample and proofs.

Main Belting Co.

1217-1237 Carpenter St. -	Philadelphia
55-57 Market St. - -	Chicago
120 Pearl St. - -	Boston
40 Pearl St. - - -	Buffalo
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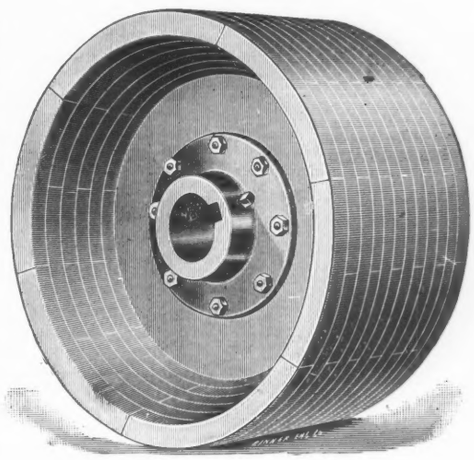
Metal Polish
Highest Award
Chicago World's Fair, 1893.
Louisiana Purchase Exposition, St. Louis, 1904.
3-oz. Box for 10 cent.
Sold by Agents and Dealers all over the world. Ask or write for FREE samples
5-lb. Pails, $1.00.
GEO. W. HOFFMAN
Expert Polish Maker,
Indianapolis, Indiana.

For Dynamos, Trip Hammers or other Heavy Work.

We manufacture a solid web pulley especially adapted for extremely severe service and guarantee that it will do the work specified, no matter how heavy. Style D. built of selected, thoroughly seasoned maple, having an iron center fitted with key seat and set screw, is the lightest, strongest, stiffest and best finished Dynamo Pulley on the market.



STYLE D. SPECIAL PULLEY.

The Gilbert Wood Split Pulleys are universally acknowledged to be as perfect, both in material and construction, as it is possible to make them, and can be used successfully wherever a leather belt can be operated. Excel all others in correctness of balance and trueness of running.

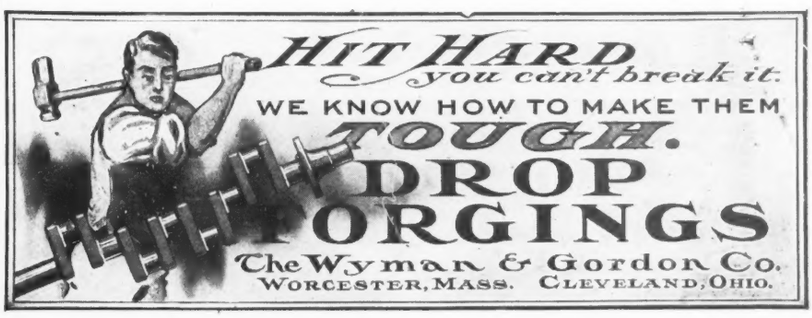
Write for illustrated catalogue and price list.

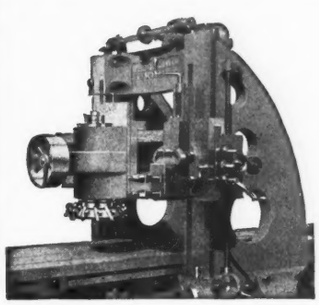
Saginaw Manufacturing Co.

Saginaw, W. S. Michigan.

SALES AGENCIES IN ALL THE PRINCIPAL CITIES IN THE WORLD.

New York Branch, 88 Warren Street. Chicago Branch, 28 32 South Canal Street.
Cable Address, Engrave. A. B. C. and Lieber's Codes.





Milling Machine

The Farwell Miller, built for Planers, will convert any planer into a combination tool on which milling, boring and planing can be done and at one setting of the work.

Means are provided for vertical, horizontal and angular positions of spindle.

It is built in four sizes.

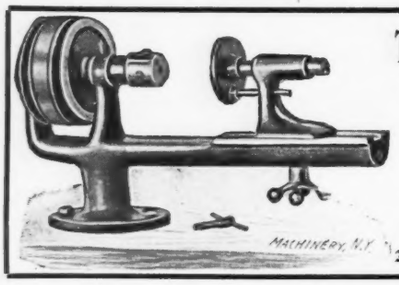
Send for Catalogue No. 55.

THE ADAMS COMPANY
Dubuque, Iowa, U. S. A.

Babbitt-Metals

FOR ALL PURPOSES

Buffalo **LUMEN BEARING COMPANY** Toronto

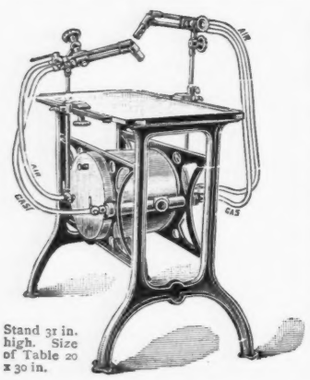


The Champion Tapping Machine

Beats them all for light high speed tapping. Taps holes either through or to depth. Capacity up to ¼" holes; automatic and rapid in operation—saves the taps.

Sent on approval—write to-day

Blair Tool and Machine Works
24 West Street, NEW YORK CITY



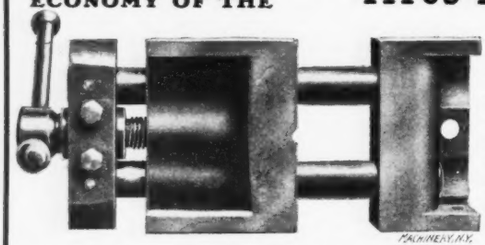
Stand 31 in. high. Size of Table 20 x 30 in.

CLEAN AND QUICK METHOD OF BRAZING

B. D. M. CO'S No. 101 GAS BRAZING STAND for tool room or manufacturing purposes, has two powerful gas blow pipes or burners adjustable in any direction. The substantial iron frame work carries also an air drum and necessary gas connections as illustrated. Equally effective for a small piece of soldering or for a heavy job of brazing requiring both blow-pipes and a built-up fire brick backing. Price, **$35.00.** Catalogue "B.M." to be had for the asking tells more about it.

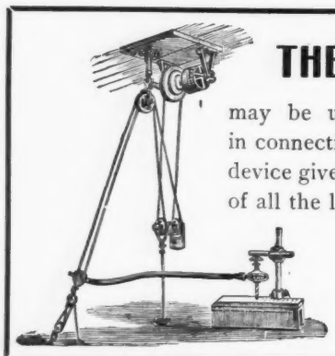
Buffalo Dental Mfg. Company
BUFFALO, N. Y., U. S. A.

THE CONVENIENCE AND ECONOMY OF THE **TITUS DRILL-PRESS VISE**



was thoroughly proven in our own shop before it was put on the market. It is especially valuable for holding light or irregular work for drilling, one jaw is grooved so that round pieces can be held securely. Guide rods are tool steel, hardened—jaws five inches wide. Thirty days' trial is a reasonable proposition—Shall we send a Vise?

TITUS MACHINE WORKS, Marion, Ohio

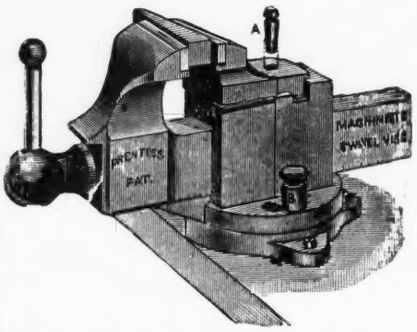


THE STOW FLEXIBLE SHAFT

may be used where electric power is not available, in connection with a rope drive as shown in cut. This device gives a large radius of action; and permits the use of all the labor saving machinery shown in our catalog. For drilling, reaming, tapping, grinding, polishing, etc., it is a shop necessity.

CATALOG ON REQUEST

STOW FLEXIBLE SHAFT CO., Philadelphia, Pa.



Machinists' Swivel Vise

with self-adjusting jaw that is as strong and durable as any solid jaw, and a Swivel Bottom that gives any desired adjustment to right or left, and is solid and firm at any angle. We make all sorts of good vises, and have been leaders in this line for twenty years. Send for catalogue and price list.

Prentiss Vise Company,
44 Barclay Street, New York.

Agents for Great Britain, Chas. Neat & Co., 112 Queen Victoria St., London, E. C.

Pat. Feb. 2, 1904

CARR TOOL HOLDERS

Model A Square Cutters — THREE IN ONE — Model B Round Cutters

Right and left off-set and straight. Best steel, drop forged and case hardened. Write for prices.

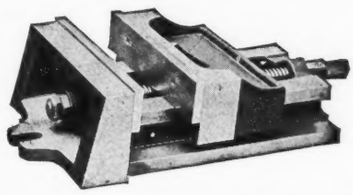
CARR BROTHERS, Syracuse, N. Y.

The Elgin Tool Works

BUILDERS OF

Light, High Grade Machinery and Tools
Watch Machinery a Specialty

ELGIN, - ILLINOIS

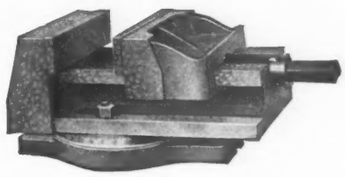


Plunket Improved Vises

Made with Plain or Swivel Base

Specially adapted for the hard service of the machine shop. Can be used with every style drill press, shaper and milling machine. Strongest construction, steel screw, steel faces to jaw, cast steel handle. Write for further information.

J. E. PLUNKET, Chicago, Ill.
33-35 W. Washington St.

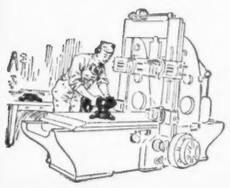


WROUGHT STEEL BAR COMBINATION BASE

MERRILL BROS., 469 Kent Avenue BROOKLYN, N. Y.

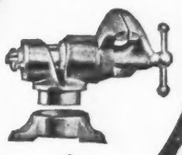
CHUCK IT

HOLDS ANYTHING
anywhere, at any angle.



Send for Booklet "B"

WITH
(and for)

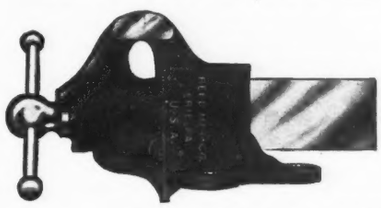


A

The Pittsburgh Automatic Vise & Tool Co. Pittsburgh, Pa.

"PITTSBURGH" VISE

The Three R's in Vise Education



"**Reed**" on a machinist's vise stands for **Reliable** construction.
Right design and satisfactory results.

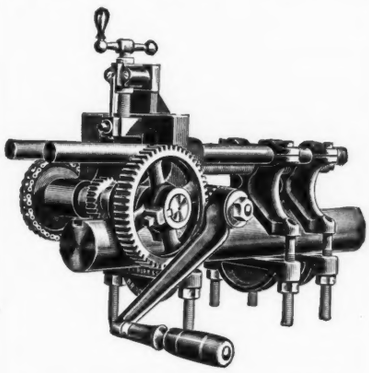
Ask your dealer for a Reed Vise and take no other. Sold under the strictest guarantee.

Catalogue H on request

REED MFG. COMPANY, Erie, Pa.

Perfect Key Seats in Shafting

Anywhere with this machine.



The Burr Portable Key Seater

is indispensable for the repair shop. Can be carried anywhere, slipped over heavy shafting or spindles, has capacity for key seats up to 5 inches diameter, and will mill a key seat 12 inches long without resetting.

This tool can be used in almost any position and in the most cramped places. It is rapid in operation, cuts without jar or chatter and produces accurate work.

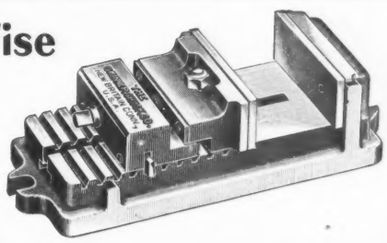
Made in two sizes—No. 1, as shown, **$40.00** net.

Send for circular.

John T. Burr & Sons,
34 South Sixth Street, BROOKLYN, N. Y.
Selig, Sonnenthal & Co., London.

Skinner Drill Press Vise

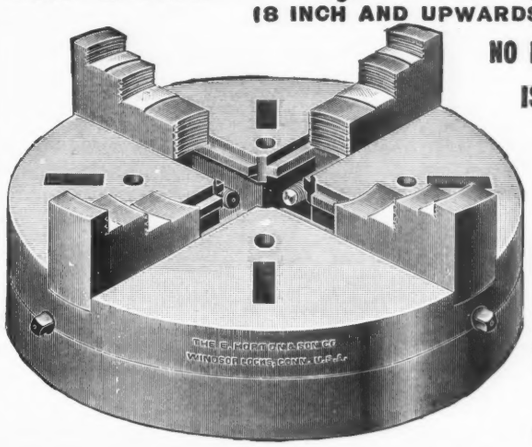
Designed on the same general lines as the Skinner Planer Chuck, but lighter and more easily used for holding work on the drill press or on other machines. It is also provided with lugs so it may be tipped on the side for drilling holes at right angles. A thoroughly practical tool. Furnished in two sizes.



The Skinner Chuck Co.
Factory, New Britain, Conn. **New York Office, 94 Reade St.**

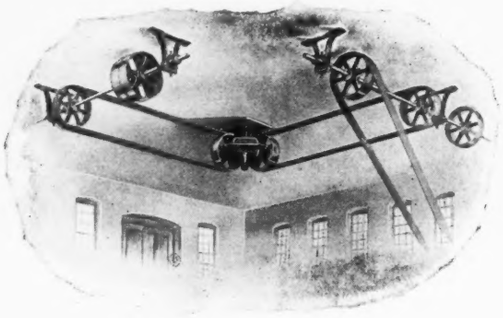
New Chuck. Heavy Universal, Four Jaws.

18 INCH AND UPWARDS.



NO EQUAL.
IS STRONG.
IS ACCURATE.
IS RELIABLE.
IS DURABLE.
IS CHEAP.

The E. Horton & Son Co.
Windsor Locks, Conn., U.S.A.



Is Your Shop Crowded?

Put in a countershaft at right angles to the main line, using an

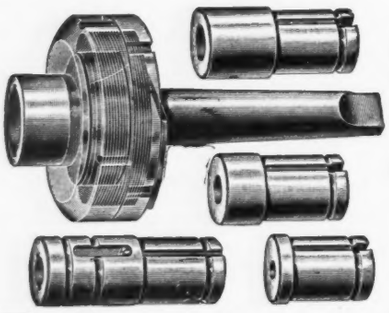
Almond Right Angle Transmission

No cost for maintenance, no noise, dirt nor trouble. Use the floor space now being wasted in the end of the shop. Write to us sending details.

Almond

85 Washington St., BROOKLYN, N. Y.

London Office: 8 White Street, Moorfields.



THE

Safety Drill & Tap Holder

is the only attachment for the purpose that gives universal satisfaction, and is

UNEQUALLED in Efficiency, Convenience, Rapidity, Accuracy and Simplicity.

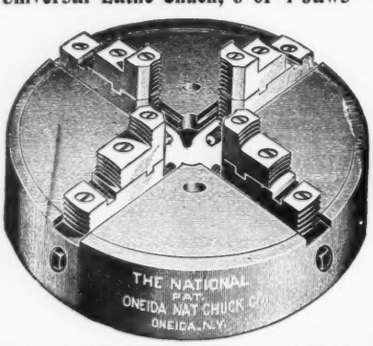
Nothing to Break or get out of Order. Made in 4 sizes, covering from 0 to 2½ in. diameter.

The Beaman & Smith Co., Providence, R. I., U. S. A.

National Improved Combination and Universal Lathe Chuck, 3 or 4 Jaws

National Drill Chuck

HAS NO EQUAL



THE STRONGEST GEAR LATHE CHUCK MADE

Send for Catalogue.

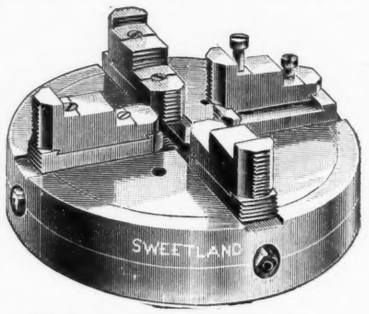
Made Entirely of Steel

DOES NOT GET OUT OF ORDER

If you have a dirty job try it. Money refunded if not satisfied.

ONEIDA NATIONAL CHUCK COMPANY, ONEIDA, N. Y.

SWEETLAND CHUCKS



SWEETLAND CHUCK No. 4

WITH REVERSIBLE JAWS

Adapted for a wide range of work. Screws relieved of all strain, all the advantages of a solid jaw.

ACCURATE, SIMPLE, STRONG AND DURABLE

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THE HOGGSON & PETTIS MFG. CO.

NEW HAVEN, CONN., U. S. A.

The Cushman Chuck Co.

HARTFORD, CONN., U. S. A.

Manufacturers of

Lathe and Drill Chucks

Catalogue Free

DRILL CHUCKS.

For sale by

De Fries & Co., Dusseldorf, Germany.

Charles Churchill & Co., Ltd., London, Eng

Trump Bros. Machine Company,

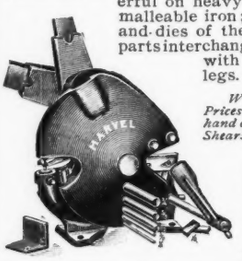
MANUFACTURERS

Wilmington, Del., U. S. A.

The MARVEL Combined Punch and Shear

Built Like a Machine Tool

The handiest tool of its kind for the machine shop. Clips bolts and rods from ⅛ to ¾ inch without crushing or marring. Cuts up to ½ x 2 inches flat; cuts angle iron up to ¾ x 2 x 2 inches. It punches ⅜ hole in ⅜-inch iron and ½ hole in ¼-inch iron. The **MARVEL** operates on the double lever system, making it quick and fast on light work and doubly powerful on heavy work. Made of malleable iron; blades, punches and dies of the best steel. All parts interchangeable. Equipped with or without iron legs.



Write for Circular and Prices of this and other hand operated Punches and Shears.

ARMSTRONG-BLUM MFG. CO.

113 N. Francisco Ave.

Chicago, U. S. A.

HOISTS,

NEW PATENT WHIP

Patent Friction Pulleys.

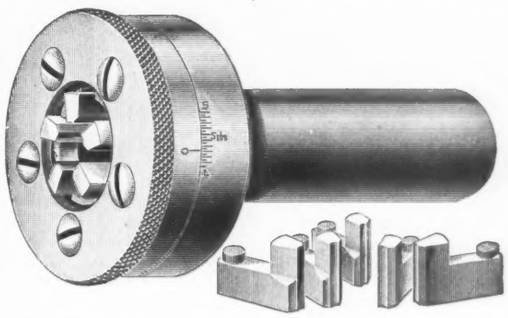
NONE BETTER

MANUFACTURED BY

VOLNEY W. MASON & CO., PROVIDENCE, R. I., U.S.A.

The Economy in Brass Finishing

To be secured by the use of this Adjustable Hollow Milling Tool is well worth consideration. No other device will so rapidly produce accurate, uniform diameters. It is made in various sizes and can be used on any Automatic Screw Machine, Hand Turret Lathe, or Rotated in any way desired. The index permits rapid setting to any diameter within its capacity, and equally quick change from one diameter to another. It will reduce work of any length, will mill close to a shoulder, and as sharpening of blades is done only at the outer edges there is very little time lost in re-grinding.



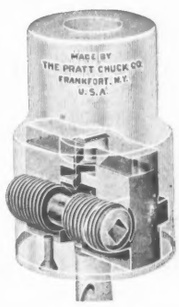
If you are finishing brass work of any kind you will be interested in a full description of this tool. Circulars mailed free.

THE GEOMETRIC TOOL CO., Westville Station New Haven, Conn., U.S.A.

FOREIGN AGENTS—Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Glasgow, Newcastle-on-Tyne. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. Schuchardt & Schutte, Vienna, St. Petersburg. Stockholm, Berlin.

You Need the Pratt Chuck

For high-speed drilling—or for any class of drilling you may have in hand. The time saving, tool saving, trouble saving qualities of the Pratt Chuck count for a great deal when competition is close and the margin for profit small. It holds the drill or tap so firmly that there is no chance of slipping or working loose, it insures quick and accurate work, it does not injure the shank of the tool. Nothing to get out of order—simple and strong in construction. Let us tell you about it.



The Pratt Chuck Company, Frankfort, N.Y.

EUROPEAN AGENTS: Selig, Sonnenthal & Co., 85 Queen Victoria St., London, England.

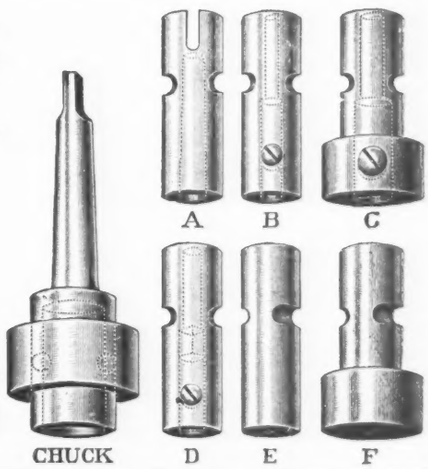
Don't Stop the Machine

to change the drill, reamer, tap or counterbore—that's a waste of time and a needless labor.

The "MAGIC" Chucks and Collets

permit the substitution of one tool for another instantly, simply and without lessening the speed of machine. Designed for use on the spindle of upright drills but applicable to lathes or other horizontal spindle tools.

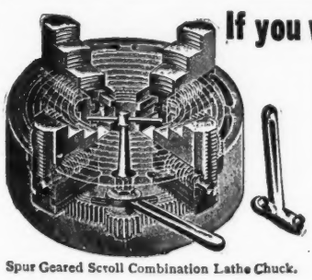
A word from you and we will fully explain the "Magic."



AGENTS: The Prentiss Tool and Supply Co., 115 Liberty St., New York. Frank H. Czarniecki Co., 335 Fifth Ave., Pittsburgh, Pa. O. P. Packard Machinery Co., 34 So. Canal St., Chicago, Ill., Milwaukee, Wis. Chandler & Farquhar, 34 Federal St., Boston, Mass. C. W. Burton, Griffiths & Co., London, Eng. J. Lambercier & Co., Geneva, Switzerland.

Modern Tool Company

Erie, Pa.



Spur Geared Scroll Combination Lathe Chuck.

If you want the best Lathe and Drill Chucks—buy Westcott's

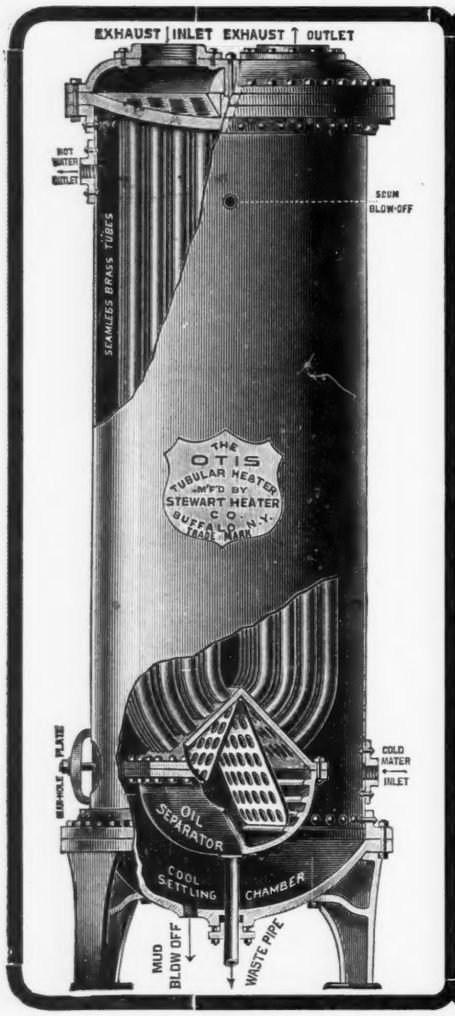
Little Giant Auxiliary Screw Drill Chucks, Little Giant Double Grip Drill Chucks, Little Giant Improved Drill Chucks, Oneida Drill Chucks, Spur Geared Scroll Combination Lathe Chucks, Scroll Combination Lathe Chucks, Geared Combination Lathe Chucks, Geared Universal Lathe Chucks, Spur Geared Scroll Universal Lathe Chucks, IXL Independent Lathe Chucks, Cutting-off Chucks.

Strongest Grip, Greatest Capacity, Great Durability, Accurate.

WESTCOTT CHUCK CO., Oneida, N.Y., U.S.A.

Ask for catalogue in English, French, Spanish or German.

Little Giant Auxiliary Screw Drill Chuck.


EXHAUST | INLET EXHAUST ↑ OUTLET
HOT WATER OUTLET
SCUM BLOW-OFF
SEAMLESS BRASS TUBES
THE OTIS TUBULAR HEATER MF'D BY STEWART HEATER CO. BUFFALO, N.Y. TRADE MARK
COLD WATER INLET
OIL SEPARATOR
COOL SETTLING CHAMBER
MUD BLOW OFF
WASTE PIPE

THE OTIS

Tubular Feed Water Heater, Oil Separator and Purifier

is not an experiment but a tried and trusted appliance that the makers are not afraid to

GUARANTEE

To heat the feed water to the *boiling point* (210 to 212 degrees) with the exhaust steam without causing any back pressure, *also to extract the oil from the exhaust*, so that the exhaust steam after being passed through the heater can be used for heating purposes, and the water of condensation for the heating system be returned to the boiler without the *additional expense* of an *eliminator*.

We are so sure of the OTIS that we agree to pay all cost of a trial—freight, cartage, piping, etc.—if it fails to do all we claim for it.

Catalogue and Prices at Your Service

The Stewart Heater Company

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POOLE ENGINEERING & MACHINE CO.
ENGINEERS, FOUNDERS AND MACHINISTS.
BALTIMORE, MD.
MANUFACTURERS AND DESIGNERS OF ALL KINDS OF
HEAVY MACHINERY,
REQUIRING FIRST CLASS WORKMASHIP AND MATERIALS.
BAND, ROPE AND FLY WHEELS. FRICTION CLUTCHES, SHAFTING, PULLEYS AND HANGERS.
MACHINE MOLDED AND PLANED GEARING.
MACHINERY for WHITE LEAD and FERTILIZER WORKS, GRAIN ELEVATORS and FLOUR MILLS, BRASS, COPPER and TIN PLATE ROLLING MILLS CABLE and MARINE RAILWAYS.
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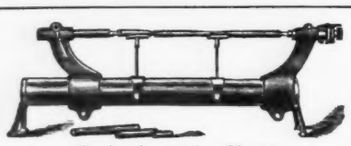
DREDGING MACHINES.
CIRCULARS ON APPLICATION.
IRON CASTINGS 30,000 LBS. TENSILE STRENGTH.

Here's the Tenth Edition

Dixon's latest book, "Graphite as a Lubricant," tenth edition, explains the modern practise of graphite lubrication and quotes experiments by scientific authorities and experiences of practical men. New, fresh, complete information in convenient form.

Write for free copy 74-C.

Joseph Dixon Crucible Co.
Jersey City, N. J.



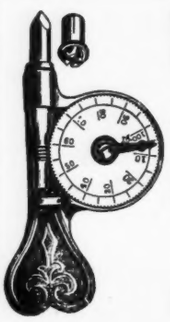
(Style of 12 and 24 Sizes.)

Measuring Machines.

Measuring screw, 10, 16 or 20 threads to the inch, graduated to read thousandths or 32ds without calculation.

The only Micrometer that will not lose its accuracy by wear.

SYRACUSE TWIST DRILL CO. SYRACUSE, N. Y.
Chas. Churchill & Co., Ltd., London, Eng., Agents for Great Britain



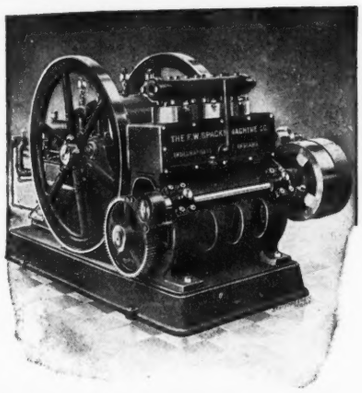
WOODMAN & HUDSON'S Speed Indicator.

An ingenious little instrument for ascertaining the correct speed of Dynamos, Steam Engines, Shafting, Floor Machines, etc. No first class mechanic, superintendent or factory should be without one. They are adapted to hollow or pointed centers, and are absolutely correct. Every indicator is handsomely nickel-plated and of convenient size to carry in the pocket.

Price: Split Cap, adapted to either pointed or hollow centers, $1.00.
Plain Cap, for hollow centers only, 75c.

We also keep a Double Registering Speed Indicator. Prices on application.

The R. Woodman Mfg. and Supply Co., 63 Oliver Street, BOSTON, MASS



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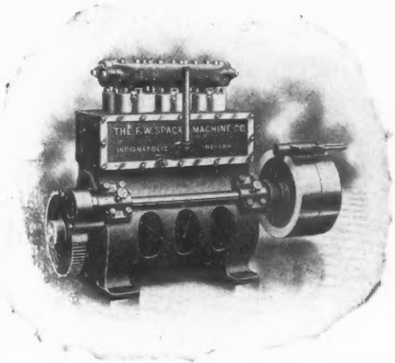
Single or Three Cylinder Styles. Belt or Motor Driven

We build Air Compressors with capacities ranging from 1 to 100 cubic feet free air per minute.

Write for full particulars.



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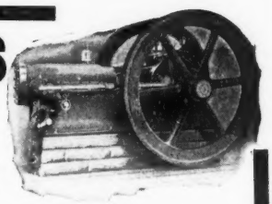
GEAR CUTTING SPROCKET CUTTING

Special department for this division of our business. Estimates furnished.

FOOS



Gas and Gasoline Engines.

Easy to handle. Absolutely reliable. Simple and durable. All parts accessible. Highest efficiency.

FOOS GAS ENGINE COMPANY, Springfield, Ohio

OTTO ENGINES

Are "Otto" Engines Dependable?

Gentlemen:—

As you will doubtless remember, two years ago last fall, we installed one of your 21 H.P. "Otto" Gasoline engines, and ran the same **103 days and nights** without stopping. One year ago water was high and the engine was not run. Last fall water was again too low to enter our intake, and the engine and pump was started on November 2, 1906, and has run continuously for 3523 hours.

Is not this a good record?

Yours truly,

Bristol Acqueduct Co.

Bristol, N. H., 4-1-'07.

OTTO OTTO

OTTO GAS ENGINE WORKS, Phila, Pa.

STANDARD OF THE WORLD

Build Your Own Gasoline Motor.

We supply the castings, drawings, and all accessories. A complete line of rough castings, also finished Motors, for Bicycle, Automobile, Marine or Stationary. A 2-cent stamp gets our catalogue.

Steffey Mfg. Co., 2941 Girard Ave. Philadelphia, Pa.

ECK Dynamo & Motor Co.

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Direct Current.

1-24 to 20 H. P.

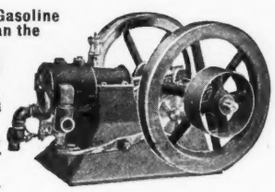
TRADE MARK

No Better Gas or Gasoline Engines made than the

FOSS ENGINES.

Simple Substantial Efficient

Catalog on request.



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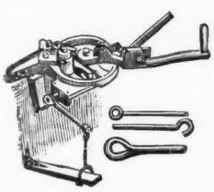
The Steiner Japanning and Drying Oven

Designed to meet special conditions. Heated by gas and adaptable for many lines of manufacture. Special burners used for drying materials containing much moisture.

Ovens for Bronzing, Japanning, Blueing, Enameling, Drying.

Made in any size required. Write for prices.

Emil E. Steiner, 50 Ferry St., Newark, N. J.



Eye Benders

We make hand power benders for forming eyes from stock 1-8 inch thick and under. Any size eye 7 inches outside diameter and under.

Wallace Supply Co.

6 West Washington St. CHICAGO, ILL.

Machine Screw Taps

Quality Accuracy Guaranteed

BAY STATE TAP & DIE COMPANY, - Mansfield, Mass.

CUTTING TEETH!

That's what Universal and Utility Blades have,—"CUTTING" Teeth

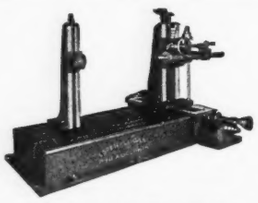
And that's what you want when you buy Hack Saw Blades—good, sharp, highly tempered, non-breakable teeth—the kind that will tackle any kind of a job and bite their way right through without injury.

That's the kind of cutting quality you get with every Universal and Utility Hack Saw Blade. Skilled manufacture and fine material place them far above the ordinary kind. They WEAR better, CUT better and ARE better.

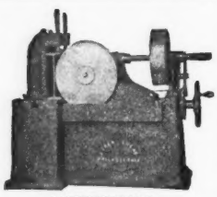
Get a catalog—Write right now.

WEST HAVEN MFG. COMPANY
New Haven, Conn.

No. 7 Bar Cold Saw



No. 2 Horizontal Floor Boring Milling and Drilling Machine



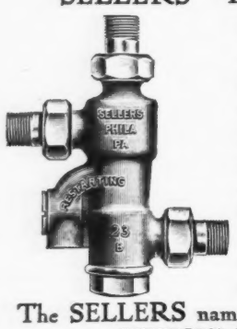
PATENTS PENDING
No. 2 I Beam Cold Saw

WRITE FOR CATALOG

ESPEN-LUCAS MACHINE WORKS
Broad and Noble Streets, PHILADELPHIA, PA.

JEFFREY ELEVATING, CONVEYING, POWER TRANSMISSION **MACHINERY** FOR CATALOGUE, ADDRESS THE JEFFREY MFG. CO. COLUMBUS, O.

SELLERS' RESTARTING INJECTOR



Has a wide range of capacities, and lifts the water promptly with hot or cold pipes. Restarts instantly after a temporary interruption of the steam or water supply.

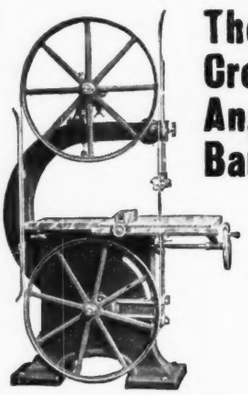
Made of the best bronze, and the workmanship is first-class throughout. Has external overflow valve and separate combining and delivery tubes. It is made to standard gauges, hence all parts are interchangeable, and injector is easily kept in repair at slight expense. Write for booklet 111.

The **SELLERS** name on an injector is a guarantee of the BEST.

JENKINS BROS., New York, Boston, Philadelphia, Chicago, London.

For all Structural Work where Rivets and Bolts are used.

PUNCHES AND DIES.
All Sizes from ¼ to 4 in. diameter.



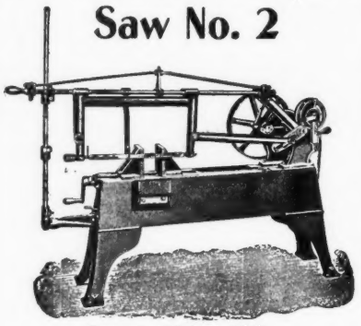
The Crescent Angle Band Saw

Cuts any angle up to 45 degrees with table always level.

The advantage of this saw is readily apparent; it saves time and labor in handling large work and insures accuracy in small work. A turn of the wheel will change the angle of the saw, and change can be made without stopping the machine. Thoroughly practical, simple and sold at a reasonable price. *Write us.*

The Crescent Machine Co.
56 Main St., LEETONIA, O.

Draw Cut Machine Saw No. 2



Capacity 10 in. x 10 in.

Cuts all kinds of cold metal, round, square or irregular shaped, smoothly accurately and in less time than any other saw of its kind.

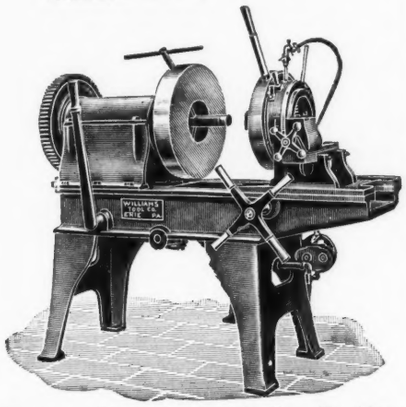
The improved features of this tool are:
Draw Cut, Geared Drive, Combination Feed, Adjustable Stroke.

Size No. 1 cuts 6" x 6". Circulars for details.

H. T. STORY
30 W. Randolph St., CHICAGO, ILL.

A Pipe Cutting Equipment

of Williams Machines will meet all requirements of modern work.



Complete Line of Pipe Cutting Machines

Newly designed, strong construction, rapid and convenient in operation. Quick opening and adjustable dies. Six speed changes without shifting a gear.

7 sizes, capacities from ¼" to 12"

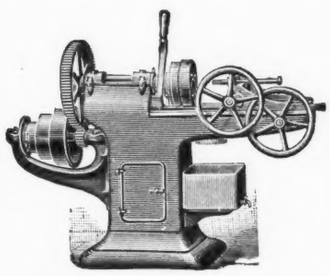
WILLIAMS TOOL CO., ERIE, PA.

UNIFORMITY OF PRODUCT

CAN BE DEPENDED ON WITH THE

Merriman Bolt Cutter

Bolts are all the same size and equally well finished.



This machine is distinguished by the very simple construction of the Head—which has but four parts—its durability and the few repairs needed. The square bearing of the dies in the ring gives them all the advantages of solid dies. The Merriman machine is very rapid and can be run by an unskilled operator.

Catalogue No. 11 gives full details

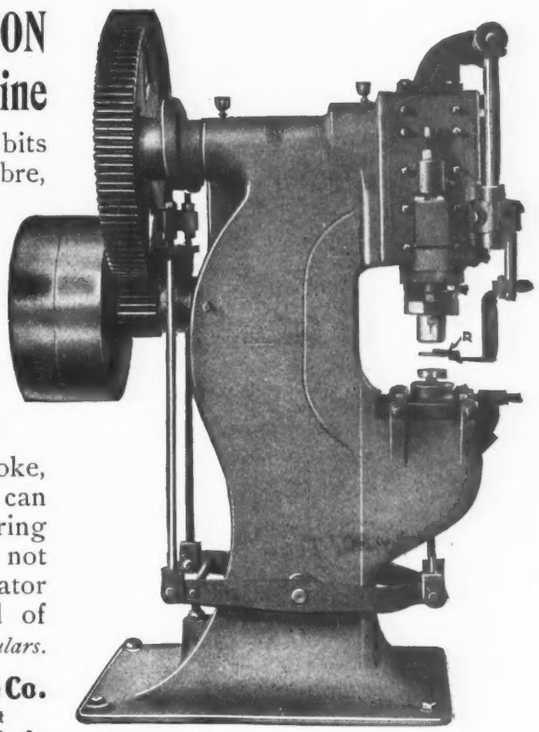
THE H. B. BROWN COMPANY
Box B, East Hampton
Connecticut

Complete Index to
Machinery's Data Sheets
will be sent on request.
The Industrial Press, 49-55 Lafayette St., New York

THE=KRIPS=MASON Punching Machine

will convert your odd bits of brass, copper, fibre, scrap iron or steel, either hard or soft, into washers, armature discs, hardware and electrical specialties quickly and at small cost.

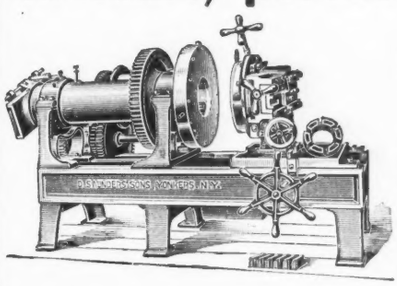
It is a great time saver, cutting and punching at one stroke, single or multiple; can be arranged for shearing when desired, does not require a skilled operator and handles material of any shape. *Write for circulars.*



Krips-Mason Machine Co.
1636 North Hutchinson Street
Philadelphia, Pa., U. S. A.

As nearly perfect as can be made

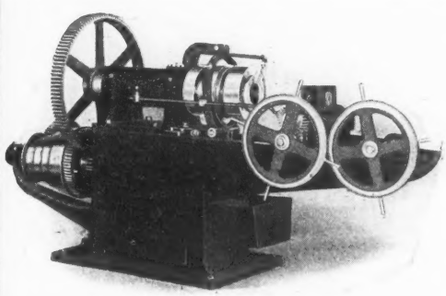
is what we claim for our



Pipe Threading and Cutting Machinery

These machines are the result of forty years' practical experience in this line of manufacture, and are unsurpassed for efficiency of operation and quality of workmanship. May we send you our catalogue?

D. Saunders' Sons, Yonkers, N. Y.



You Can Double Your Capacity

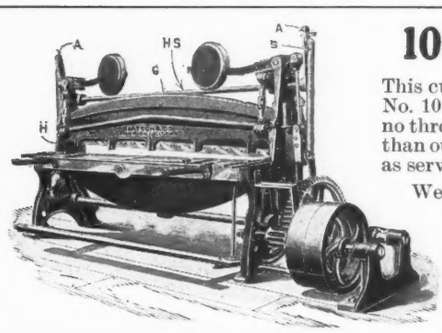
For Threading and Cutting Bolts by Installing

STANDARD BOLT CUTTERS

The Standard Head is unequalled for simplicity, durability and accurate product; the dies are adjustable and easily set to cut over or under size; threads cut are equal to lathe work, and once started a Standard Bolt Cutter looks after itself.

Catalogue?

Standard Machinery Co.
BOWLING GREEN, OHIO



10-ft. No. 0 Shear

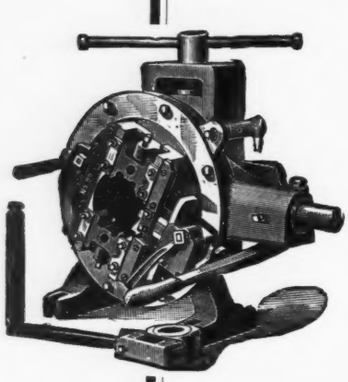
This cut shows our No. 0 Shear built for No. 10 gauge sheets. Note that it has no throat, hence it is lighter and cheaper than our regular Mill Shear, but it is just as serviceable for some classes of work.

We build a complete line of

Shears, Punches and Bending Rolls,

all sizes, for hand or power drive.

BERTSCH & CO.
Cambridge City, Ind.



Take the Machine to the Work

If it isn't convenient to bring the work to the machine.

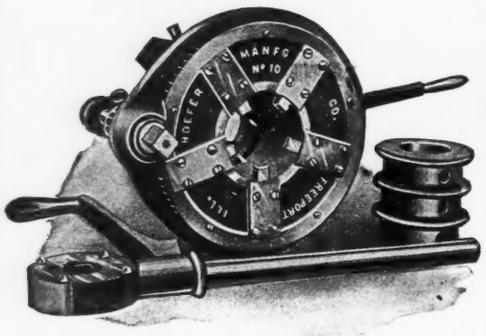
All sizes of Armstrong Pipe Cutting and Threading Machines up to 4 inches are portable and can be easily moved to the work outside or inside the shop.

All sizes, even the 6-inch machine can be turned by hand when power is not available.

Catalogues and prices on application.

The Armstrong Mfg. Co., 297 Knowlton Street, Bridgeport, Conn.

Chicago Office, 23 South Canal Street.



Adjustable Hand Power Pipe Threading Machine

The Hoefer Adjustable Hand Power Pipe Threading Machine

will thread pipes of any material, requires but one man for its operation and does the work quickly and accurately. The Dies are fed forward, and withdrawn automatically, insuring perfectly clean cut threads. One set of dies will cut all sizes of thread within the capacity of the machine, saving much time and the trouble of changing dies, and by a quick and simple adjustment can be set to cut over or under standard size. The machine is simple in operation, does not get out of order and all moving parts are protected from dirt and chips.

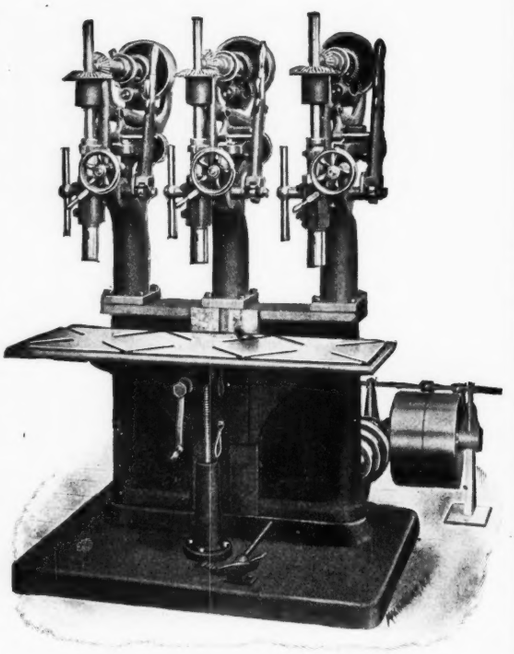
Our full line of manufacture includes **Drill Presses, Metal Saws, Horizontal Drilling and Boring Machines, Vertical Boring Machines, Wire Straighteners, Pipe Threading Machines, Furniture and Bed Spring Machinery.**

CATALOGUE ON REQUEST

Hoefer Manufacturing Company

Corner Chicago and Jackson Sts., Freeport, Ill.

FOREIGN AGENTS—C. W. Burton, Griffiths & Co., London, England. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao. J. Lambercier, Geneva, Switzerland.



21-inch Gang Drill

Pipe Threaders and Cutters

With efficiency as well as beauty.

Heavy—none more so; bed cast in one piece, no stands nor legs to work loose. No oil soaked floors; fire risk reduced.

Single speed pulley; all-gear speed changes through semi-steel cut gears.

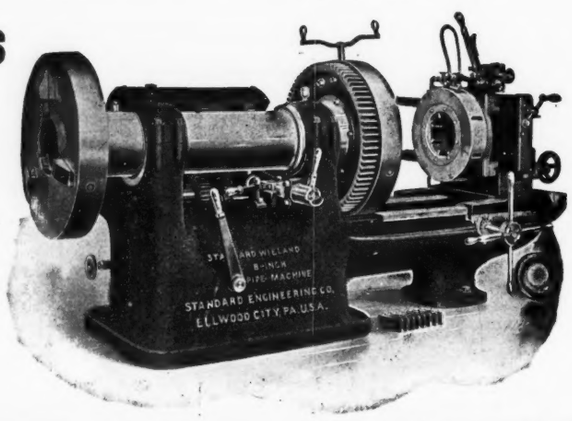
Deep chasers cutting long taper perfect threads in one cut as easily on steel as on iron pipe.

Let us prove to you that the higher cost for a modern tool is justified by the character and quantity of its product. Circulars for the asking.

Standard Engineering Co.,

Ellwood City, Penna.

St. Louis Office: 1012 Chemical Bldg.

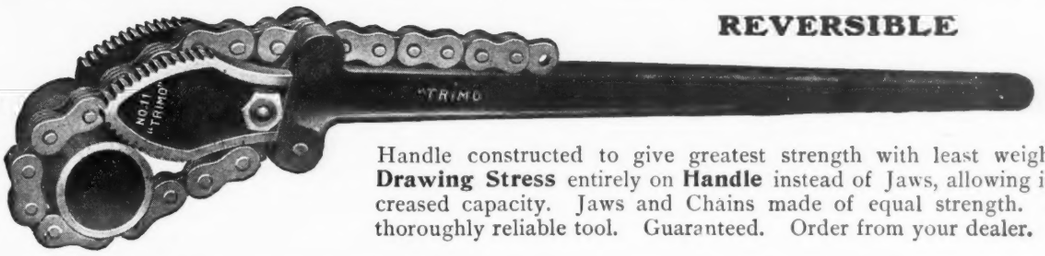


"TRIMO" Strongest of All Chain Wrenches

REVERSIBLE

Gold Medal St. Louis 1904

Send for Catalogue No. 38 showing full line



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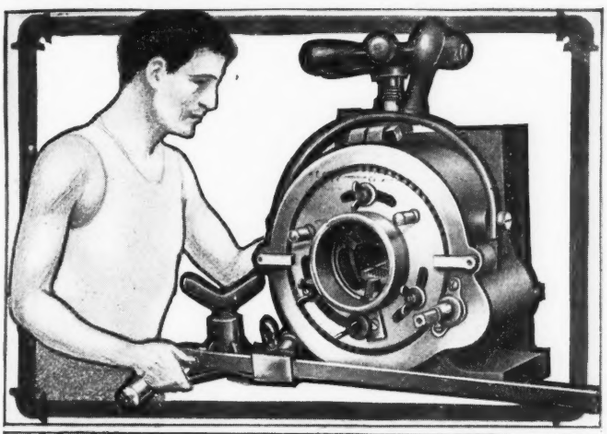

HERE are many arguments in favor of Forbes Patent Die Stocks.

Before the Forbes machine was invented the pipe threading proposition was a serious problem. With the Forbes instrument it is possible to cut and thread pipe up to sixteen inches by hand power. The operation is extremely simple—*one man can do the work of four* and do it better.

Interesting catalogue if you'll write.

THE CURTIS & CURTIS COMPANY,
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With a **"KEYSTONE" SAFETY SHACKLE-HOOK**

Quick Acting.

You are free from all anxiety about the load slipping or becoming detached.

There is positively no chance for such an accident, because the "Keystone" is absolutely safe. Saves lives, saves property and adds to the efficiency of your equipment.

Write for price list. Especially valuable in the construction and operation of railroads.

Close Fitting.

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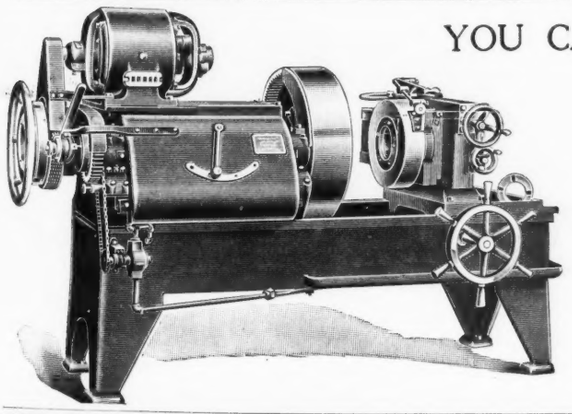


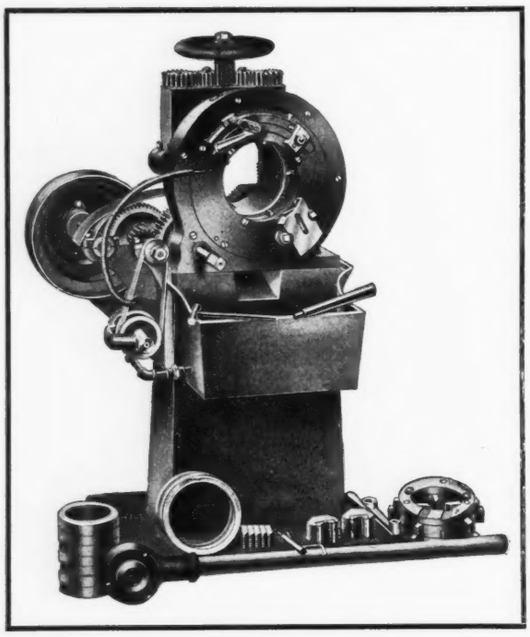
YOU CAN PUT THE PIPE IN THE MACHINE FROM EITHER END

If you have a Sliding Die Head. Just push the head to one side and there is no danger of hurting the dies by dragging the pipe across them.
You can cut off closer to the gripping chuck, too; this will often save the time of rechucking the pipe.

(The 4-inch motor driven machine shown has our Steel Clad Sliding Head.)

The Stoever Foundry & Mfg. Co.
MYERSTOWN PA.

A STRONG CLAIM--READ IT
A GREAT MACHINE--TEST IT



WE say—any Merrell Pipe Threading and Cutting Machine turned out of this shop will not only *equal*—but *better*—the record of *any* other pipe threading and cutting machine ever built.

And we'll ship this Merrell, anywhere, for 30 days free trial to prove it.

Now do *your* part.

This Combination Hand and Power, Portable or Stationary Merrell is the only machine made that will cut and thread satisfactorily, 10 and 12 inch pipe when in use as a hand machine.

It operates simply, easily and economically—and it *always* operates—without hitch, or breakdown.

Cuts any style or pitch of thread, and any size or kind of pipe up to 12 inches.

In writing for further information please address

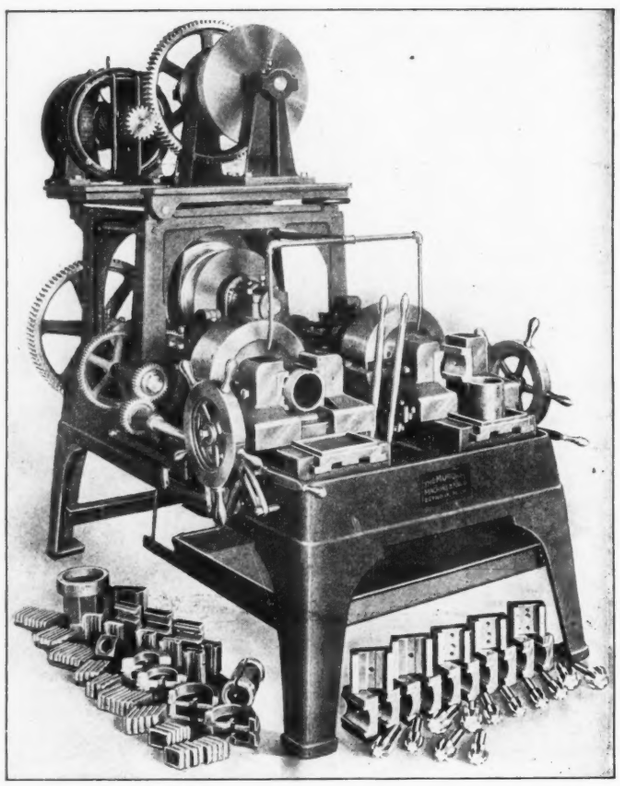
THE MERRELL MFG. CO., 15 Curtis St., TOLEDO, OHIO

Murchey Double Head Nipple and Pipe Threading Machine

MOTOR DRIVE

LEAD SCREW ATTACHMENT

NEW STYLE DIE HEADS



These machines are four times as rapid as the old style pipe machines and the most efficient and convenient tools of their class.

Thread and ream at one operation.

Automatic Dies insure perfect threads without any attention after the work is once started. Specially designed gripping chuck jaws. Improved nipple holders.

We also build the

Murchey Improved Tapping Machine

with patented frictionless driving head.

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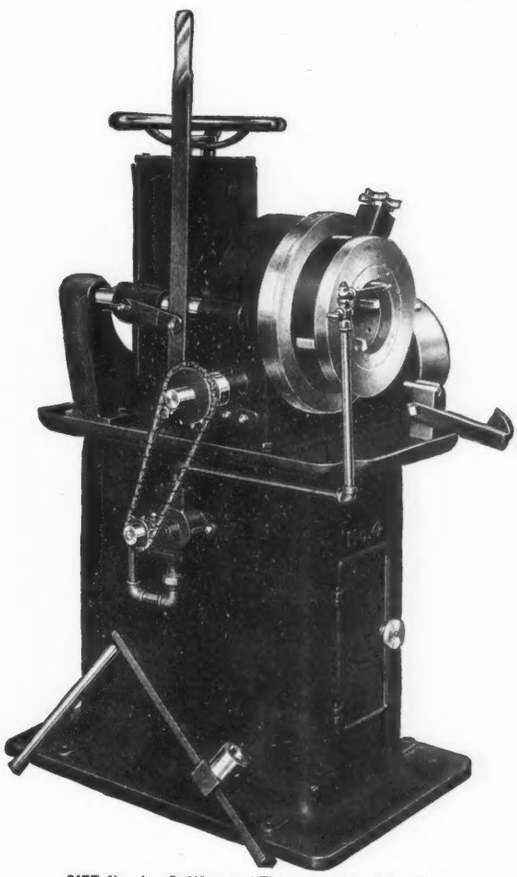

SIZE No. 4. Cutting and Threading 1 to 4 in. Pipe.

The Loew Victor Pipe Machine

Adaptable to all classes of pipe threading and its low cost places it within the reach of every one having use for a power machine.

Let us tell you about it—it's worth investigating.

The Loew Manufacturing Company

Cleveland, Ohio

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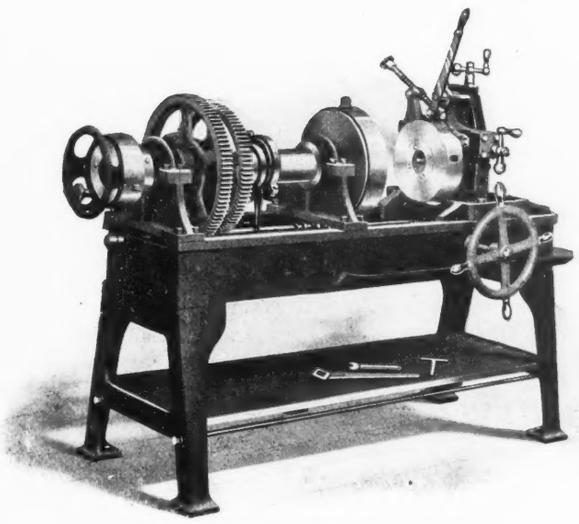

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CIRCULAR IF YOU WANT IT.

For a combined PIPE and BOLT threading machine up to two inches this machine has many advantages.

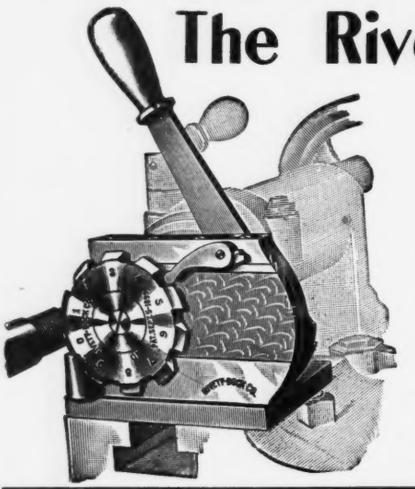
With the PEERLESS DIE HEAD the dies can be instantly released.

Extra LONG BED for cutting long threads on bolts.

UNIVERSAL GRIPPING CHUCK on the front, and SCROLL CENTERING on the rear of the arbor.

Bignall & Keeler Mfg. Co., Edwardsville, Ill., U. S. A.

The Rivett-Dock Threading Tool



Has beaten the old single point tool to a standstill and is still rolling up new records. When you have accurate threading to do, and duplicate work this tool is practically indispensable—it not only does better work but will do it in from 1-3 to 1-10 the time formerly required, can be operated by unskilled labor and needs very infrequent grinding.

Let us send a tool on thirty days probation. A trial will convince you. Send for latest catalogue.

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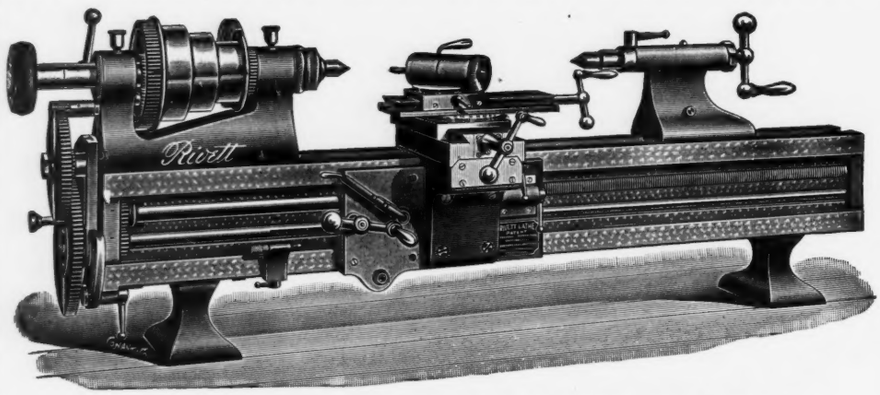
For Toolmakers, Makers of Fine Instruments, For Experimental Work



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comes nearer to the ideal than any other tool made. Though designed and adapted for the most delicate operations it has strength and rigidity to stand much heavier work and is equipped with every improvement.

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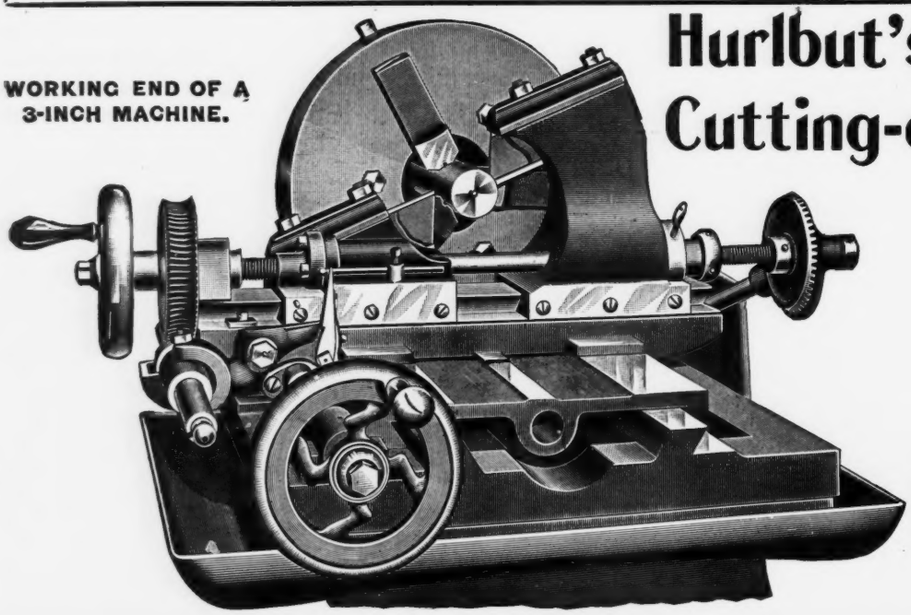

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Gear Speed Change Upright Drilling Machines

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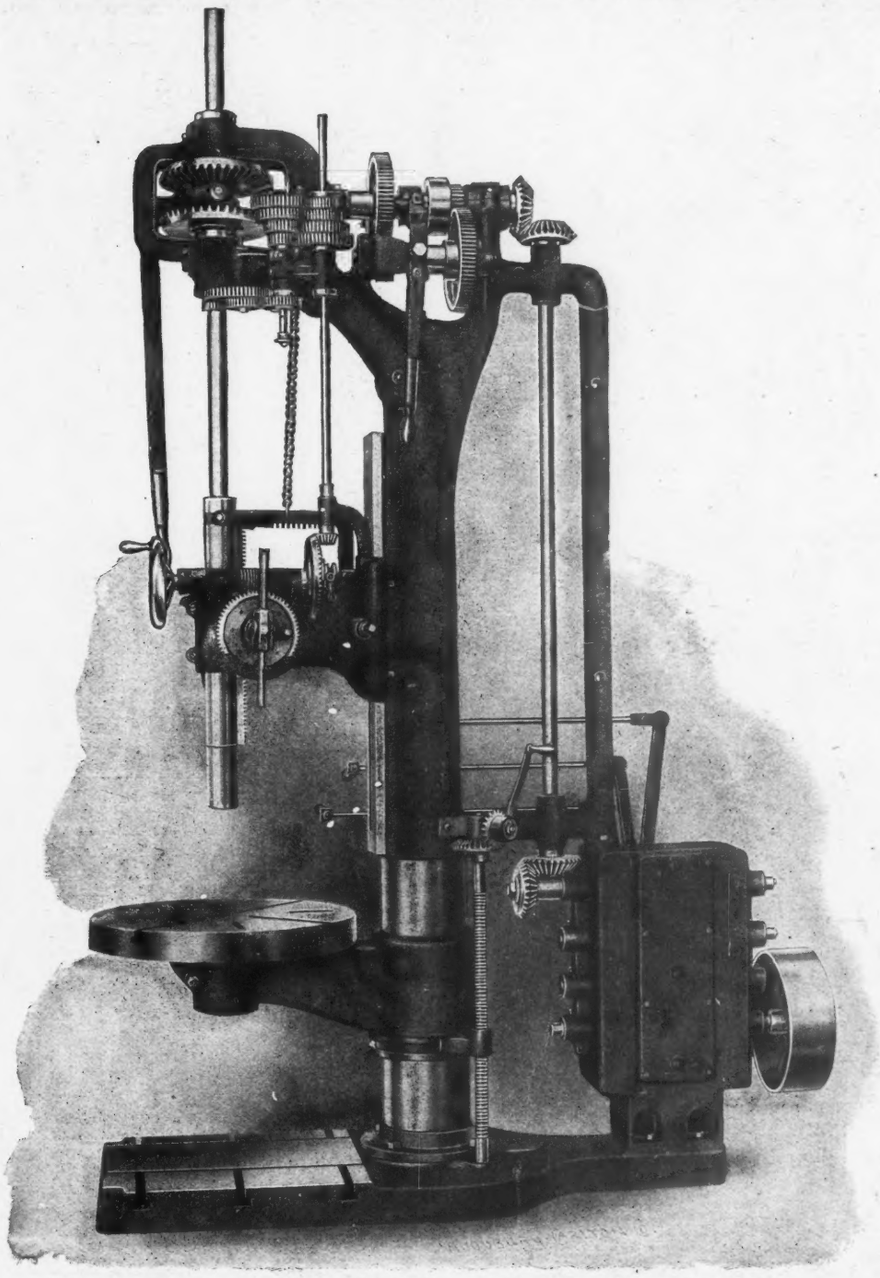

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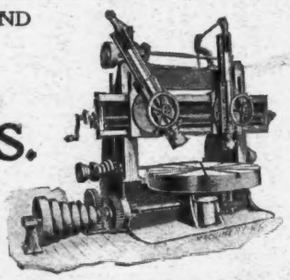

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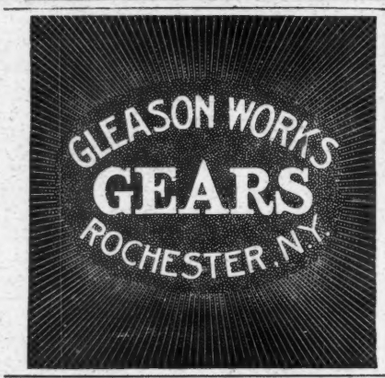

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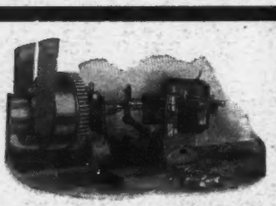

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